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Their Uses in Health and Disease

By

F. HOWARD HUMPHRIS, M.D.

WITH A FOREWORD BY

SIR J. PURVES-STEWART, K.C.M.G., C.B., M.D.

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M.D.(Brux.), F.R.C.P.(Edin.), D.M.R.E.(Camb.)

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London, 1930. Published Jointly by

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PRINTED IN GREAT BRITAIN

FOREWORD

BY

SIR JAMES PURVES-STEWART, K.C.M.G., C.B., M.D.

THE rapid advances during the last few years in treatment by sunlight and ultra-violet rays, not only of skin diseases but of numerous other maladies, call for a popular and authoritative work, in which the subject shall be discussed by someone who possesses authority together with the power of clear exposition. Both of these requirements are fulfilled by this book. Dr. Howard Humphris, the author, is a notable research worker in the subject. He possesses, moreover, the happy gift of lucidity, as will be seen in the following pages. This excellent work will be read with interest and profit both by the layman and by the medical practitioner.

J. PURVES-STEWART.

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CHAPTER ONE

HISTORICAL

As far back as the creation of the world, light has been an essential to life. Light, in some form or other, is a necessity for the well-being, the very existence of human and other animal life. Without light, human health is impossible, and one might as well add, human existence unthinkable.

Research shows that light, as rays of the sun, was used as a remedy or as a form of medical treatment from the earliest era of which any record exists. And before any record was made there is still to be found evidence that the prehistoric cave-dwellers realized the value and importance of the light-rays —since their habitations were so placed as to receive the maximum amount of light from the sun. The effects of the sun rays evoked a spirit of well-being in these prehistoric peoples, and the sense of joy which they thus derived prompted a spirit of gratitude, and they wanted to thank somebody, or something, for the benefits that the sun had conferred, and thus, may it be, were sown the first seeds of worship. The first religion then followed as a necessary corollary, and these prehistoric folk worshipped what they considered the fount and origin of their health and happiness, the Sun. Is this the origin of all religion? True it is, in any case, that sun-worship is the first religion of which any record exists. It was the sun which sowed the first seeds of religion. Religion, in the beginning, was an expression of gratitude, that gratitude for benefits received and which only

later came to be an expression of hope of favours to come.

Sun-worship was the first religion, and it was out of this religion that the idea of a personal God was evolved. Medical treatment by the sun's rays was, in all probability, practised by the inhabitants of Mesopotamia, who were in existence 7,000 years ago. The ancient Assyrian arranged a sun-bath on the housetop or roof of his house.

More than 3,000 years ago Akhnaton, Pharaoh of Egypt, " Son of the Sun," as he delighted to call himself, founded a definite religion of sun-worship, of which the symbol exists to this day. It represents the sun's disc, from which extend numerous rays, each ray ending in a hand or hieroglyphic, signifying Life, a true representation of the life and health-giving properties of the sun. It must be clearly understood that there was no idolatry in this. The symbol itself was not worshipped, but rather the life-giving, the intangible essence, which it typified. This essence or spirit was known as Aton, or Aton-Ra, and was the first deity conceived by mortal man who was neither tribal nor national. Models and mural decorations have been found in Egypt depicting the life after death which the devout Egyptian expected, or, at any rate, wished and for which he prayed, and his friends and relations prayed for him. The thing for which they hoped and prayed above all others was sunlight. All the avocations which they were in the habit of pursuing on earth, such as ploughing, sowing, reaping, fishing, and so forth, they pictured as taking place in their beloved, worshipped light of the sun, Aton-Ra, the giver of health and

happiness. Akhnaton himself coined the title "Aton Ra," which, perhaps, may be translated as " the effulgence derived from Aton."

The value of the sun's rays would appear to have been recognized as being good for the body, apart from any symbolic value to the soul. This may be inferred from some of the prayers of the Egyptians which have been in existence from time immemorial and only a few words were changed to suit the religion of Aton. The disciple of Akhnaton asked to be allowed " to go out from the underworld in the morning to see Aton as he rises." He prayed insistently, passionately in varied language, that his spirit might " go forth to see the sun," that there might be " no failure to see it," that the " vision of the sun's fair face might be never lost to him," that he might " obtain a sight of the beauty of each recurring sunrise," and that the sun's rays might "spread over his body."

Akhnaton, the royal high priest of the sun, founded in Egypt the religion of the worship of the god of the sun. He taught that the rays of the sun made pregnant the whole earth. The god of the sun was the god of fertility, fecundity, generation, reproduction, and the like, in the human, animal, and vegetable kingdoms. One must be moved with involuntary admiration for the young king who in such an age found such thoughts in his heart.

Herodotus, born *circa* 480 B.C. at Helicarnassus, has left it on record that light was to be regarded by the physician who knew his business as a prefatory means of repelling illness and as a subsequent aid to recovery. Herodotus has borne

excellent testimony to the calcium-forming properties of sunlight and of its use in the treatment of baldness. It was on an occasion when Herodotus was in Northern Africa, and was visiting the site of the old battlefield of Pelusium, that the inhabitants pointed out to him that the skulls of the Persians were soft, while those of the Egyptians were hard. He says: " I saw the skeletons of those on both sides, who had fallen in the battle, piled up separately from one another; among the skeletons of the Persians, the skulls were so weak that by throwing a pebble you could make a hole in them; on the other hand, the skulls of the Egyptians were so strong that you could scarcely break them by striking them with a heavy stone. The inhabitants gave as a cause, and easily convinced me of its truth, that the Egyptians from their earliest childhood have their heads shaved, and so by the action of the sun the skull becomes thick and hard. This is also the cause why they do not become bald; for among the Egyptians one sees the fewest bald heads of all mankind."

The sun is the greatest remedial agent. The Roman historian Pliny, at the time of Christ, wrote: " Sol maximum remidiorum est," and Cicero and the younger Pliny tell us that *solaria* were established in the villas of Rome's leading citizens. The Father of medicine himself, Hippocrates, born 460 B.C., mentions and practised the sun cure at the famous medical school, Cos, in the Greek Archipelago. In his work on " Living " he recommends those who wish to reduce their figure to walk about naked. Hippocrates, too, drew attention to the favourable effect of sunlight on

disease, and wounds of various kinds, and on compound fractures.

Æsculapius, the God of Healing, was the son of the Light-God, Phœbus Apollo. In the temple of Æsculapius at Epidaurus (in Argolis), a gallery has recently been discovered open to the air, facing south. This gallery leads off a general ward, and it is fairly obvious that it was used by the Æsculapian priests to put their patients out on it under the rays of the sun.

When Rome was at the height of her greatness sunlight treatment was being prescribed by her physicians, Aulus, Cornelius, and Celsus, in the reign of Tiberius, recommends sunlight for those who are debilitated, corpulent, or suffer from dropsy, but he says " not too much lest it bring on fever."

Antyllus, a Greek surgeon who lived 1,600 years ago, gives a description of a sunbath in detail, and says that it hinders increase of body weight, strengthens the flesh, makes fat disappear, and reduces the size of indolent ulcers. . . . Those who suffer from chronic weariness of the head will find sun useful, strengthening them and hardening them against disease.

One could quote for a long time from the ancient authorities and bring evidence to show what was thought of the value of sunlight in those days. Did not Diogenes say to Alexander the Great: " Get out of my light," showing how much he valued it? But perhaps I have wandered long enough in the realms of the past, but linking up those ancients with the workers of this present century, we have evidence of sunlight being used as a therapeutic

agency by several nations of to-day. Germany, perhaps, takes the lead. The old Germans put their sick children on the roof of the house, exposed to the sun. They had also "recovery places" situated on bright, sunny heights. In fact, as Dr. Bernard of St. Moritz says: "The Sun Worship of the Germans created a kind of climatotherapy which one can follow through the whole of their 'folk medicine.'[1]"

Italy, too, has carried on heliotherapy learned from the ancient Romans, and the saying about an apple a day is happily replaced by the Italian proverb: "When the sun enters, the doctor doesn't."

And so the history of sunlight has now been sketched, all too briefly, down to the present time. And the history of sunlight, in England, at any rate, only began a few, a very few, years ago. The first book dealing exclusively with the subject was published less than five years ago, namely in September 1924. Prior to this date, apart from the installation of the Finsen light at the London Hospital, to which reference will be made later, actinotherapy, or treatment by light, was practised by the few, and was unknown and unnoticed by the many. It is to Isaac Newton, a little over a hundred and twenty years ago, that we owe so much of our knowledge of light and radiation. It was Newton's epoch-making discovery of the spectrum that revealed an unexplored and well-nigh virgin field in the territory of radiant energy and the composition of light. But his knowledge

[1] *Light Treatment in Surgery*, Translated by S. R. King Brown.

was limited to the visible radiation. With the more delicate apparatus now available a vast series of radiations, differing in respect of wave-lengths and frequency of vibration, is now within the scope of our knowledge. These extend at either end of the visible spectrum. Those beyond the violet are known as the ultra-violet, and those below the red are called infra-red. Newton served as a bright torch to lighten the way, not only of those such as Römer and Huygens of his own time, but of those such as Scheele, Ritter, and Herschel, who came after him. Later Thénard, Gay-Lussac, and Planché added their quota, and so down to what may be termed "our own times" and the work done by Daguerre, Becquerel, and Röntgen.

In dealing with the modern history of light in this country one must restrict the meaning of the word to those rays which are artificially produced. Though the treatment of disease in Switzerland by Arnold Rikli, at Samadan by Dr. Oscar Bernhard in 1902, and the opening of a sunlight clinic by Rollier at Leysin, 1904, began, at any rate, with rays derived from the sun itself. In this country Sir Henry Gauvain has done, and is continuing to do, monumental work at Alton. Less than five years ago London had its first sun-bathing establishment, and facilities for treatment were commenced at Kenwood, adjoining Hampstead Heath. At the same time, or very shortly after this, artificial sunlight was established by the management of the Theatre Royal, Drury Lane, for the benefit of anyone connected with the theatre who wished to avail themselves of its advantages. This was done, not for the treatment of disease, but in order

to keep the *artistes* and staff fit and well. This installation of an ultra-violet department at Drury Lane Theatre was, as far as can be ascertained, the first time that artificial sunlight had been instituted among adults as a purely preventive measure, and I ventured then to prophesy that the example set by our National Theatre would blaze the trail along which many would eagerly and gratefully follow. Since then that prophecy has been fulfilled. One of the earlier proofs of the progress was the Sherwood Colliery demonstration. The management of the Sherwood Colliery in December 1927, from humane and philanthropic motives, built a clinic thoroughly equipped for artificial sunlight treatment.

Another milestone on the pathway of progress of light-ray therapy was the foundation of the London Clinic. This was formed under the ægis of the British Humane Association by the munificent benefactions of Louis Campbell-Johnson, whose death in March of this year is so much to be deplored. This clinic was founded for those who could afford to pay something towards the cost of treatment, but could not afford the individual services of a medical practitioner, while at the same time they were not legally qualified for free hospital service.

The London Clinic specializes in the various forms of light therapy, which it supplements by other physio-therapeutic measures, and has a capacity for treating one thousand cases daily. The constitution of the clinic varies in no way from that of an ordinary hospital, and a large number of patients are treated without payment; but those who can afford to contribute to the cost

are asked to do so. It is worked under the patronage of the Venerable Order of St. John of Jerusalem in England and the Royal Red Cross Society. It was the first institution employing artificial sunlight in which clinical instruction and teaching was given, combined with the examination of candidates, and the granting of certificates of proficiency to successful students.

It is difficult to tabulate or even enumerate the many ways in which artificial sunlight has progressed during the last two or three years. Its advance has not been marked by milestones ; it has rather resembled a shower of meteorites. Sunlight centres have grown up all over the country : many devoted to infant and maternal welfare, others to industrial prosperity. Artificial sunlight is being and has been installed in general and special hospitals. The latest development is, perhaps, its use in mental hospitals. It is being applied commercially to foodstuffs, and notably to milk. This was demonstrated at the World's Dairy Congress held in London in the autumn of 1928, where the efficacy of irradiated milk in the prevention and treatment of rickets was shown.

Light rays are being used in the training of athletes, though this is ancient as well as modern history, for Philostratus tells us that the athletes of old, entering for the Olympic Games, were ordered to take sun-baths as an essential part of their training.

Artificial sunlight has its uses in veterinary medicine. Horses and dogs are alike receiving its benefits. Stock-breeders are using it, more especially those breeding pigs and poultry.

Apart from these and other commercial uses, there is a trend of public opinion towards the prevention of illness—that is, towards the treatment of health by light rays. Not that this is anything new, for Hippocrates, who was born nearly 500 years B.C., pointed out the favourable effect of sunlight and its use in the treatment of health.

To-day this is shown by the establishment of municipal quartz light baths in many cities and towns (Bradford, Leeds, Castleford, Bingley, Stockport, Dundee, Hull, etc.). These are centres for sun-bathing—for the healthy rather than for the treatment of disease. Doubtless the names of many of the places where artificial sunlight is being used have been omitted, for their number increases month by month. It is being administered, apart, of course, from the specialist, by the general practitioner, and by the patient, by all kinds of clinics and establishments, some under medical control others not. In private it is used alike by those who should use it as well as those who should not.

Artificial sunlight today is in almost universal use, administered sometimes scientifically, sometimes empirically ; but as our knowledge of the physical qualities of this energy increases and its biological action becomes better understood, so will the empiricism fade away and a science emerge, useful in the knowledge of medicine and a weapon forged, useful for attack upon disease and valuable in defence of health.

Ultra-violet radiation stands historically today, not only a necessity of modern therapy, but an essential in the treatment and prevention of disease.

CHAPTER TWO

INTRODUCTION

LUMINOUS rays are derived primarily from the sun and stars; and, as has been shown, the light of the former has been recognized from the earliest days of man as possessing health-giving properties.

Light is not easily defined in a few words, but Sir Oliver Lodge has described it as " an electro-magnetic disturbance of the ether." Ether is the name given to that extremely tenuous matter which is supposed to pervade all the space of the universe and the undulatory theory of light is based on the hypothesis that light is propagated by waves or vibrations of the ether.

Sunlight is made up of several kinds of light rays, and besides these we are familiar with Hertzian and wireless waves, X-rays, radium rays, etc.

SPECTRUM

(Fig 1) DIAGRAMATIC SPECTRUM ANALYSIS

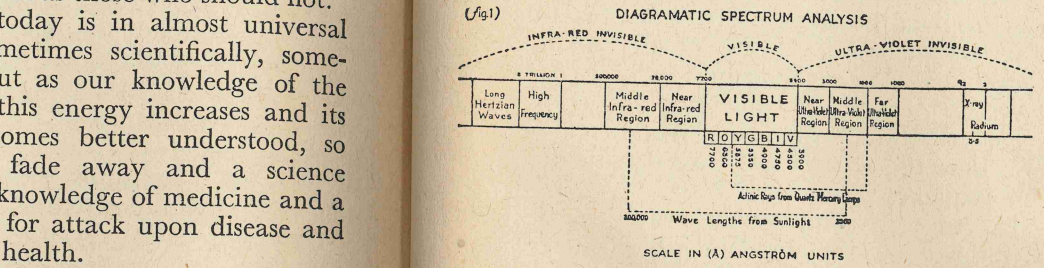


FIG. I.

All the rays at present known to science can be arranged so that they follow one another in a continuous electro-magnetic spectrum according to

their wave-lengths. It will be noticed that visible light occupies a very small space, and Luckiesh says, " If a normal spectrum of the entire range of wave-lengths of radiant energy could be produced and the portion of it due to visible radiation—light—were a foot long, the entire spectrum would be several million miles in length."

Immediately below the red visible rays come the infra-red rays. These are the heat rays, and although they have been known for so long their therapeutic worth has only just been recognized, and some of the good results obtained previously from light and radiant heat treatment are undoubtedly due to the infra-red rays.

The ultra-violet rays, which we are chiefly considering, occupy a small band immediately above the violet end of the visible spectrum. Ultra-violet rays embrace the actinic rays which have the power of exciting chemical action and of producing photographic effects.

Rays are classified according to their wave-lengths, i.e. the distance between two successive wave-crests. The velocity of all radiant energy transmitted through a vacuum is the same: 186,300 miles per second. By dividing this figure by the wave-length the frequency of vibration is obtained, and thus the shorter the wave-length the greater the frequency.

In order to compare the wave-lengths which, in the case of visible and invisible light are excessively minute, a unit of measurement is necessary, and the one adopted is known as the Ångstrom unit (Å). This represents one ten-millionth of a millimetre.

Sunlight is very rich in ultra-violet rays, but the shorter wave-lengths, which are those mainly used in therapeutics (Gr. Θερχπευο = I treat) are absorbed by the atmosphere, and on account of the pall of smoke and dust that overhangs our great towns and cities still more rays are cut off, so that the town-dweller seldom, if ever, receives an adequate amount of ultra-violet radiation.

Sunshine is absolutely essential to our well-being, and this is evidenced by the general feeling of depression and of " being out of sorts," which is so common towards the end of winter months, or when there has been a long succession of sunless days.

There is no better cure than natural sunlight treatment or heliotherapy; this is carried out at its best in Switzerland at such clinics as those of Bernhard at Samadan, and Rollier at Leysin. In the clear mountain atmosphere the sunlight is particularly rich in ultra-violet rays, the sun shines for many hours daily, and its light is little obscured by smoke or mist.

Heliotherapy is hardly possible in this country owing to our fickle climate, but Sir Henry Gauvain has achieved great success in the treatment of children at his clinic at Alton and Hayling Island, but even there it is necessary at times to have recourse to artificial means when sun is too long absent.

Artificially, ultra-violet rays are produced by means of the electric arc. In the open arc lamp, the arc adopted by Finsen—the pioneer of this form of treatment—which is similar to that once used in street lighting, carbons are generally

used, usually impregnated with chemicals which increase the ultra-violet output. In other types of this lamp tungsten or iron electrodes are adopted. In the closed arc lamp the arc burns in an atmosphere of mercury vapour enclosed in a sealed fused quartz tube. Quartz is necessary because ultra-violet rays for the most part will not penetrate glass. This fact has led to the production of special glass which is permeable to ultra-violet rays, the best known being Vita-glass. This glass is being used for the glazing of windows in nurseries, schools, bathrooms, and the bedrooms of chronic invalids, and thus enables those much indoors or absolutely confined to the house to receive a modicum of natural ultra-violet radiation.

The effects of ultra-violet radiation on the body may be divided into general and local.

Generally they act as a tonic and stimulate all the natural processes of the body. The blood is enriched and its calcium, phosphorus, and iron content is augmented, the stability of the nervous system is increased, and the ductless glands, such as the thyroid, rendered more active. Ultra-violet rays have a profound effect on nutritional disorders due to deficiency in vitamins in the diet, and have a specific effect on rickets, which is essentially a disease caused by lack of sunlight and a deficiency of vitamins, particularly vitamin D. The rays not only replace the vitamins lacking in the diet, but enable the body to form vitamins of its own. Ultra-violet ray treatment is very successful in cases of tuberculosis, especially when the bones are affected and a large number of cures are obtained.

Locally, the first effect noticed is an erythema of

the skin, that is, a redness which appears some time after the application of the rays. When the body is exposed repeatedly to the rays it gradually becomes brown. Pigmentation of the skin is Nature's defence against too great a quantity of the rays. In the case of fair people pigmentation may not occur and the skin becomes intensely reddened and subsequently peels. Such a result may also follow an overdose of the rays. In the treatment of skin diseases such as psoriasis or eczema a dose is frequently given to promote desquamation. Ultra-violet rays are bactericidal, and hence are used in the treatment of septic wounds, boils, and sluggish ulcers, and are of prime value in the treatment of skin diseases of infective origin.

As a general rule in applying the rays the initial dose should be small in order to avoid too intense an erythema. Many factors control the dosage and will be dealt with later. It is important that the rays should, as far as possible, strike the skin at a right angle, and where this is not possible the duration of exposure must be increased, for instance, at an angle of 60 deg. the time must be increased by one-third and at 75 deg. by two-fifths. An important factor to be remembered is that these invisible rays follow the laws of light, and their power varies inversely as the square of the distance, thus if the skin-arc distance is halved the same dose will be obtained in a quarter of the time.

Special care must be taken in the treatment of the very young and the very old as they appear to be particularly susceptible to the action of the rays. In certain cases it may be necessary to produce an intense erythema even to the extent of blister

formation; a reaction of this type, provided that the area treated be small, subsides in a short time and no permanently injurious results occur. A severe erythema should on no account be obtained over a large skin area, the effects produced will resemble closely those following an extensive burn and may be severe, so much so that only recently a woman died from a duodenal ulcer that had been induced by a gross overdose of ultra-violet rays.

Properly handled ultra-violet rays can be of inestimable benefit to the human body, but it must not be forgotten that these rays are protoplasmic poisons and if none of the rays leaving the sun were filtered out by the atmosphere before its light reached the earth, life of all kinds could not exist.

Great care must be taken in the use of even the simplest " home " sun-lamp as with any electrical machine, and already several lives have been sacrificed because proper precautions have not been taken. It is dangerous for a lamp to be installed in the bathroom because, with the possibility of the wet floor and with the bath and water-taps within reach, there is grave danger of an " earth " being established as the lamp is switched on, and the whole of the main current passing through the body of the person operating the lamp.

The description of the different lamps and apparatus used in the production of ultra-violet rays will be kept as simple as is possible, but mention of some electrical terms will be inevitable and a definition here of the more important will, perhaps, simplify the understanding of what is to come.

Ampere.—Unit of strength of an electric current. It

is that afforded by an electro-motive force of one volt against a resistance of one ohm.

Alternating Current.—Current whose direction is periodically reversed.

Direct Current.—Also called the continuous current. A current whose direction is constant as distinguished from an alternating current.

Ohm.—The practical unit of resistance.

Rheostat.—An instrument for regulating the resistance to an electric current.

Transformer.—An instrument for changing an alternating current into a direct current and *vice versa.*

Volt.—The practical unit of electro-motive force. It is that E.M.F. which would cause a current of one ampere (*q.v.*) to flow against a resistance of one ohm.

Watt.—The unit of electrical consumption; it is the amount of current consumed when a current of one ampere flows at a pressure of one volt. A Board of Trade unit = 1,000 watts.

CHAPTER THREE

APPARATUS

A GREAT variety of lamps has been evolved for the production of ultra-violet rays, and these lamps are of many types. Each type of lamp has its special purpose, and though one lamp may serve various uses it will be seen that the physician, who wants consistently good results, needs to be equipped with an adequate armamentarium and a specialized knowledge of actinotherapy.

Ultra-violet radiation is derived from electric arc lamps. An arc is a flame formed by an electric current passing between two terminals. An intense illumination is produced, consisting of the invisible ultra-violet rays together with the visible light rays. The radiation from most lamps is cold, but in the higher powered carbon arc lamps a considerable amount of heat is generated, so that they must not be brought too near the skin or a heat-burn will occur.

Arc lamps are of two main types—open and closed arcs. An open arc burns in the air, while in the closed type the arc burns in an atmosphere of mercury vapour in a fused quartz tube. The two distinct types emit a different quality of radiation and are used for different purposes. In tabular form they may be set forth thus:—

Open arcs ..	carbon / tungsten ..	local and general use.
Closed arcs ..	air-cooled ..	local and general use.
Quartz mercury vapour	water-cooled	local use.

The carbon arc lamp was the type first used in

actinotherapy, and was made famous by the work of Finsen in the treatment of lupus.

The carbon arc emits intense radiation in the near ultra-violet region (*see* Spectrum). The rays are more like those of natural sunshine than those of other lamps and have greater penetrating power, while many people prefer them on account of the pleasant warmth that is also obtained.

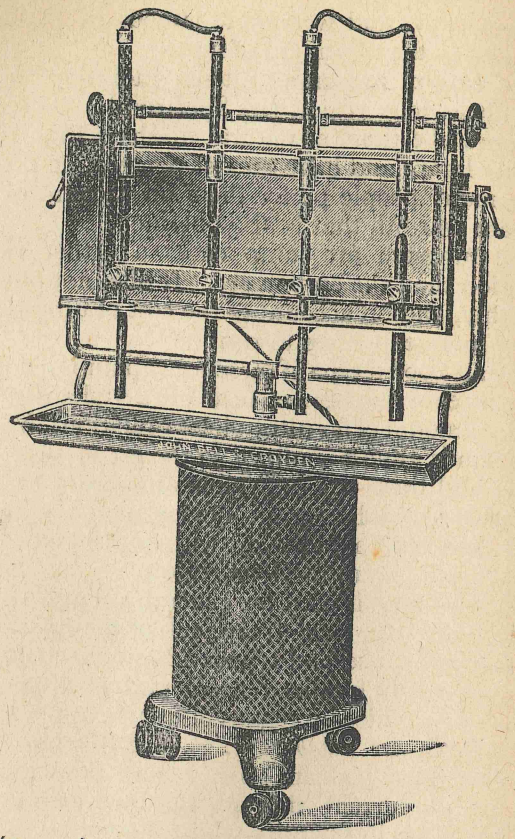
The tungsten arc lamp emits a rather richer radiation than the carbon arc. It does not burn as smoothly, and on account of the cost of tungsten, is rather more expensive to run.

The air-cooled type of mercury vapour lamp gives off an intense radiation of near ultra-violet rays and a lesser amount of far ultra-violet radiation. Visible radiation is almost confined to the green, blue, and violet, and there is a negligible amount of heat.

The water-cooled, or Kromayer, mercury vapour lamp, furnishes a radiation with a preponderance of rays in the far ultra-violet region.

The first type is used for general radiation of the body or for the local treatment of comparatively large areas; the second type is adopted in the treatment of small localized areas and is applied to orifices or cavities by means of quartz applicators.

Quadruple Arc Lamp (Fig. 2).—In this lamp four arcs are arranged in series. The amperage or volume of current through the four arcs is thus undiminished in quantity whilst the voltage is used up by the resistance offered by each arc. Therefore the output from this arc lamp is quadrupled though the same volume of current as for a single arc is used; four times the radiation is thus produced, instead of the current being wasted in resistance.



(FIG. 2.) ARNOLD "ALPINE SUN" QUADRUPLE ARC LAMP.

The striking device is worked by merely a $\frac{1}{4}$ in. turn of a hand-wheel which is placed on top of the reflector, striking the four arcs simultaneously. The

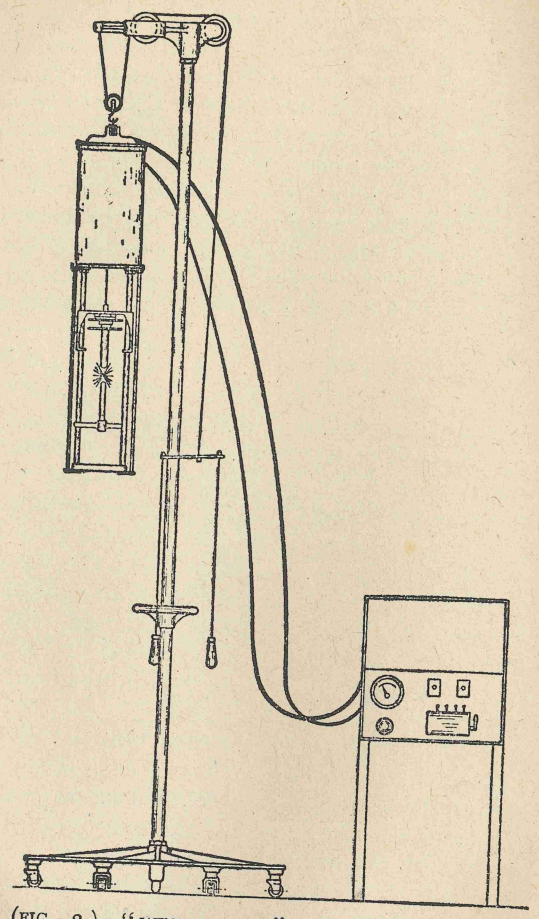
lamp is so arranged that it will keep burning for ten minutes before re-striking is necessary. The electrodes are arranged alternately positive and negative so that an even radiation is given off from the lamp. It is not correct in lamps of this type to have all the positives on top.

The lamp is fitted on a specially low stand. This is an important point, especially in the treatment of babies and little children. The resistance is contained in a round casing on the base. Castors of a special pattern are fitted to allow of easy movement in all directions.

Long-flame Arc Lamps (Fig. 3).—These lamps, of the radial type, are used in clinics and hospitals for collective treatment and because of their robust construction and mechanical efficiency withstand successfully the heavy usage which they receive. The principle upon which these lamps operate allows a 2 in. to $2\frac{1}{2}$ in. flame arc to be maintained. By using "White Flame" carbons, which have proved very satisfactory for general treatment, an extremely wide range of wave-lengths is obtained, which is particularly desirable for general collective treatment. This lamp will burn without attention for six to nine hours.

There are many patterns of carbon arc lamps (Fig. 4) which are suitable for home use. They are usually fitted with a single pair of carbons which may be adjusted by hand while burning. These lamps work off the ordinary lighting circuit.

Tungsten Arc Lamp (Fig. 5).—This lamp is specially designed for hand use or for attachment to a portable stand. It is provided with a plane surface and a concave reflector. The front hood can be



(FIG. 3.) "WESTMINSTER" SUN RAY LONG-FLAME ARC LAMP.

removed by undoing a single screw and slipping it straight off. The arc is then uncovered and for general irradiation of the entire body the flat reflector is used. For concentration on a portion of the trunk, the concave reflector should be used. The fitting on the stand and the lamp may be rotated in any direction. The stand itself folds up so that the lamp is easily portable, and it may be connected to the ordinary lighting supply.

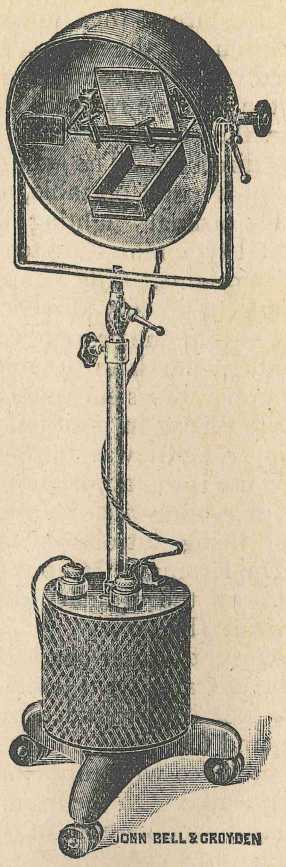
In the hospital type nine tungsten arc lamps are fitted to three uprights. The lamps are movable and can be angled in any direction. They are separate units, so that one or more can be used at a time. The patient stands in the middle of a platform and the apparatus is surrounded by curtains, which are easily placed in position.

The Kromayer lamp was introduced in 1906. Its therapeutic use is the application of ultra-violet rays to small areas and orifices of the human body, water cooling being introduced as in Finsen's apparatus. The Kromayer lamp is a compact unit which operates on the ordinary domestic electric supply and wiring (Fig. 6).

The direct-current burner consists of an inverted U-shaped tube of transparent fused rock crystal.

The quartz tube is surrounded by an evacuated quartz jacket, and the whole is built into a compact metal casing provided with tubes for inlet and outflow of cooling water. On the front of the casing is a circular quartz window 2 in. in diameter, which allows emission of the radiation.

The burner is mounted on an horizontal arm which travels on an upright pillar giving ample latitude of adjustment.

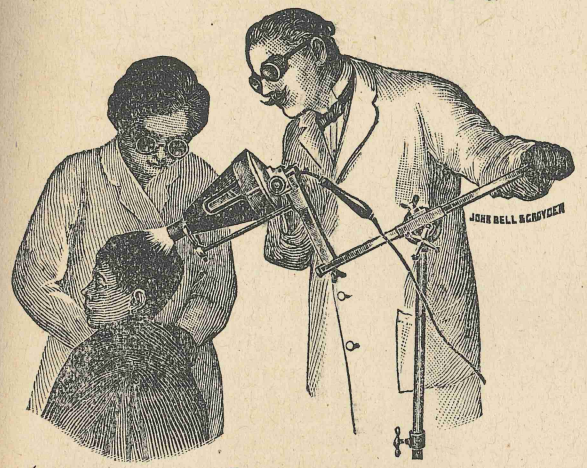


(FIG. 4.)

"ARNOLD" SINGLE CARBON ARC LAMP

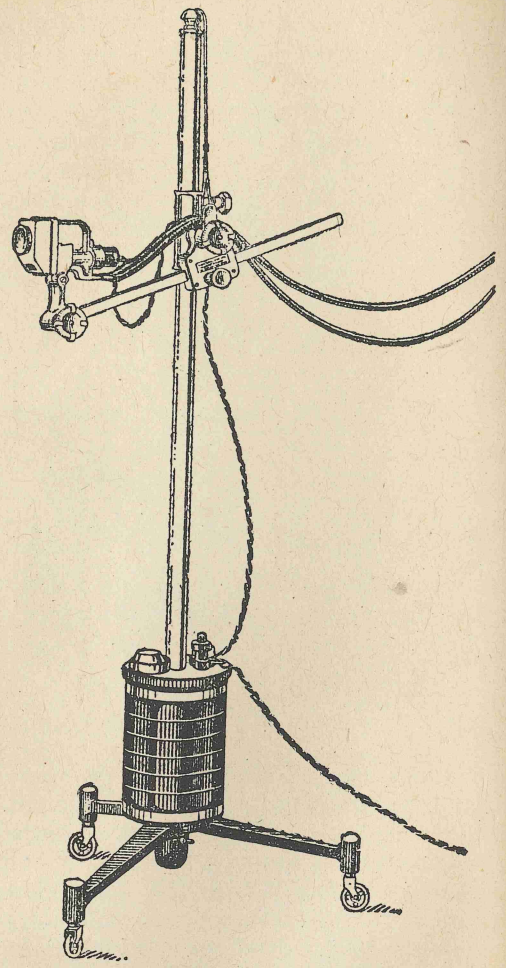
The arc is struck by tilting the lamp after the current is switched on, and the lamp reaches its full efficiency after burning for about five minutes.

The "Alpine Sun" lamp (Fig. 7) consists of a standard evacuated type, mercury-vapour burner mounted in a double-domed reflector. This is carried on an horizontal arm which has counter-weighted vertical movement on an upright stand.

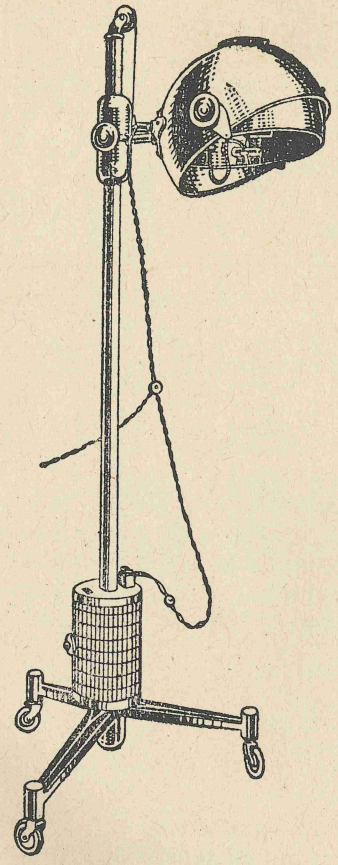


(FIG. 5.) "ARNOLD" TUNGSTEN ARC LAMP IN USE.

The stand has a substantial base carrying the resistance and switch. The usual adjustments are provided and the lamp operates on either direct or alternating current. The lamp is suitable for general irradiation. With the dome closed, local treatment can be given through a circular aperture in the lower half of the dome and various applicators can be fitted for cavity treatment.

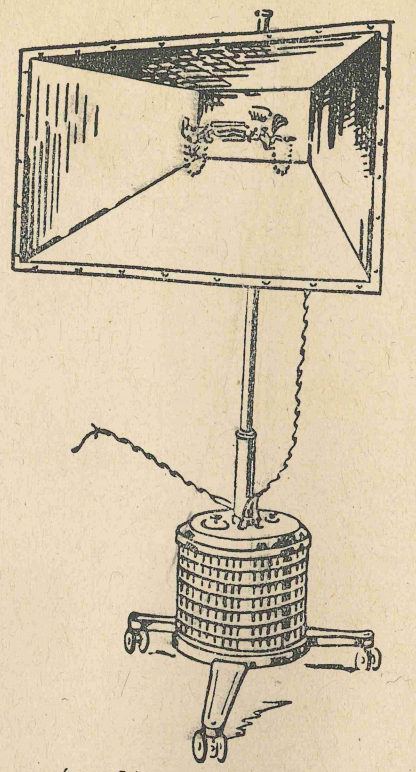


(FIG. 6.) THE KROMAYER LAMP (BRITISH HANOVIA CO.)



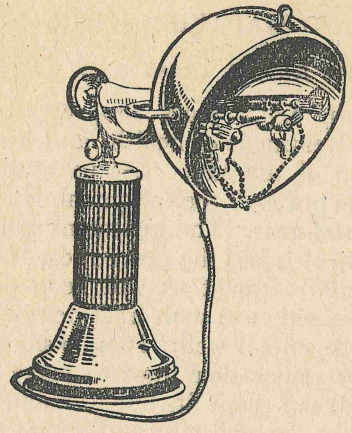
(FIG. 7.)

THE HANOVIA "ALPINE SUN" QUARTZ MERCURY LAMP.



(FIG. 8.) JESIONEK LAMP.

The Jesionek pattern of this lamp carries the burner in a rectangular reflector which projects the rays horizontally. This lamp is designed for collective treatment in light clinics where several patients are treated simultaneously.



(FIG. 9.) THE HANOVIA " HOME SUN " LAMP.

The Hanovia " Home Sun " lamp is a miniature mercury-vapour lamp. The lamp is mounted on a small pedestal for table use and can be run off the ordinary electric light current. Its power is about one-third of that of the full-size models.

CHAPTER FOUR

SUNLIGHT IN THE TREATMENT OF HEALTH

HIPPOCRATES, 2,350 years ago, was the first to preach the treatment of health, and his treatment was the use of the sun. Let us examine, for a moment, the phrase " the treatment of health " and try even to define it. The treatment of health is the keeping of health and the prevention of disease. It implies such treatment as will keep people well, in contradistinction to such treatment as will make them (i.e. ill people) well. It is no small matter to keep people well rather than to make them well, not only to keep them fit, but to make them fitter than they are, to maintain and create that feeling of well-being which should be ever present in every human body, to enable them to feel the joy of life, the joy of work, the joy, indeed, of just being alive.

Such were the objects that the respective managements of Drury Lane Theatre and Sherwood Colliery had in mind when they instituted treatment by artificial sunlight for the benefit of those employed by them, and it may be interesting to see some of the effects of the treatment in these two places; dealing as they do with individuals differing widely in life environment, work, and, for the most part, sex.

As has already been seen, the management of Drury Lane Theatre installed, under medical supervision, an artificial sunlight department about five years ago, so that anyone connected with the theatre could have the benefit of this old, yet new, treatment of health. This was done, not for the

treatment of disease, but in order to keep the *artistes* and staff fit and well. The results have been most satisfactory. The first report, made some fourteen months after this installation of ultra-violet light in the theatre, mentioned that of those who had availed themselves of its advantages, not one *artiste* had been " out of the bill " for a single performance, while of those who had not visited the sunlight department, nearly everyone had, during the very long run of the piece, either missed one or more performances, through catching cold or other cause, or had fainted or had otherwise shown some sign of ill-health.

Since the inauguration of sunlight at the theatre, four plays have been produced and had long runs, and it is an interesting fact that all those whose names appeared in the list of sunlight takers during the run of the first piece, " Rose Marie," are in the cast of the latest production, and have been re-engaged for each successive performance, and more than one sunlight bather has been promoted from chorus to small part characters, and as it is known that one of the actions of artificial sunlight is to increase mental activity and improve muscular agility, may not the artificial sunlight have been a contributing factor in the success of these actors and actresses?

Turning now from the theatre to the colliery, here an entirely different kind of people is concerned, set in surroundings totally distinct, yet the results or the state of health following artificial sunlight showed an equally striking improvement. From humane and philanthropic motives, the management of the colliery built a clinic attached

to it, perfectly warmed and lighted, furnished with shower-baths and equipped with a dozen ultra-violet lamps and a resident physician, specializing in actinotherapy, was sent down to take charge of it.

A strong committee was appointed which went down at intervals to the colliery. It eventually issued a carefully considered report of twenty pages which may be briefly summarized :—

One hundred lads were selected, of ages varying from 14 to 17 years. These were of the same physical type, ages and home conditions. One half of these were given treatment by ultra-violet rays twice weekly, and the other half were kept under control and observation. At the outset of the demonstration both groups were weighed and measured. At the end of three months the boys of each group were re-weighed and measured. Without reciting details and actual figures, which are set forth at length in the official report, it may be stated shortly that the average gain in weight per boy in the treatment group was *nearly double* that of the average increase in weight in the control group. Similarly, it is shown that the average increase in height amongst the treatment group was 50 per cent. over that of the control group. The general appearance of the fifty boys in the treatment group had improved considerably. A marked air of brightness and cheerfulness was noticeable as compared with the control group. Nearly all the boys in the treatment group told us that their appetite had improved and that their work seemed " to come easier " to them.

To-day there are many centres all over England

for the treatment of health—reference has already been made to them—and many more are springing up month by month.

Mention perhaps may be made here that at the London clinic, recognizing the first importance of the *time* factor in preventive work, all forms of service to children are free of cost, and this institution undertakes to give them preventive treatment without charge. Here combined tonic light baths and physical training classes, which are most valuable in preventing many forms of disease, are free to all children who may be permitted to avail themselves of them, and special arrangements are made for schools to attend *en bloc* at agreed hours and fixed days.

So much for general considerations as showing the value of artificial sunlight in the treatment of health. It may be asked here—and elsewhere, perhaps, later on—how is it that this remedy is of such universal good? Why does it suit everybody? And these questions may best be answered by asking another, namely—Does a holiday visit to the seaside suit everybody? Does not such a change of air make for the treatment of health? Does it not brace everyone up for the whole year, and cause all to have a more cheerful outlook upon life in general? If the visit be made to the High Alps of Switzerland or the Pyrenees where ultra-violet is more abundant, the benefit expected to be derived is even greater. In fact, the more sunlight—i.e. the greater proportion of ultra-violet rays—so much more is the health-gain to be expected.

It is not intended to suggest, at any rate not in

this book, that artificial sunlight is more efficacious in the treatment of health than a visit to the sunlit shores of the Mediterranean, an ocean voyage to Madeira, or a holiday in Switzerland; but these, however delightful, are not always within the reach of practical politics. The French have a proverb—"When we cannot have what we like, we must like what we have," and the employment of artificial sunlight is the practical application of that proverb for the dwellers in London.

We can get from artificial sunlight those rays by which health can be maintained. Research has brought knowledge of this so that now any particular ray or group of rays can be thrown upon the body, and that ray selected which is most suitable for the needs of the patient. How often should ultra-violet rays be administered to maintain or preserve good health? The answer is different in different individuals. Even as some people require more holidays than others, so differing doses of artificial sunlight are required in different individuals. In a very able report issued last July by Dr. Lissant Cox, of the Lancashire County Council, the following passage occurs :—

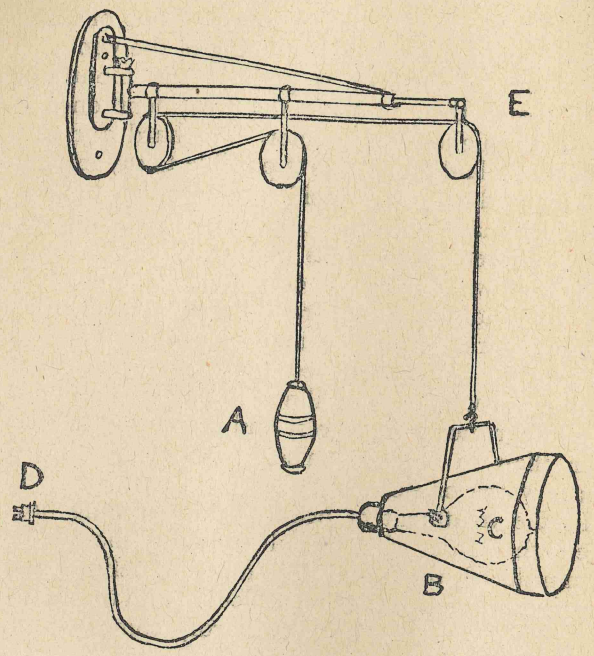
"No general rule can be laid down as to how particular persons will react to the light, as the response to the treatment varies within very wide limits. It cannot be too strongly emphasized that each patient must receive individual treatment and medical attention so far as initial exposure and graduation of exposure is concerned. Wherever possible a test exposure should be made before beginning treatment, in order to ascertain the sensitivity of the skin."

In many cases the treatment of health by artificial sunlight means two courses a year, each course consisting of bi-weekly treatments and lasting a month or six weeks. Another and convenient method is to give a month's course of two or three weekly treatments in the beginning of the winter—the month of October is perhaps the month of choice—and then to have the treatment once a month throughout the winter. No hard and fast rule can be laid down. Is it possible to say exactly how many days at the seaside are necessary to keep any given man in health? Again, no two people are alike, different individuals require different treatment and what makes it even more complicated, the same individual requires different treatment at different times, even as a man or woman who has overworked or over-played more one year than another, or who has had illness in one year and not in another, needs more rest and recreation in that year than in a year passed without any extra work, worry or sickness.

In the treatment of health before settling how often the dose of artificial sunlight should be administered, the initial dose must be defined and here is encountered the first difficulty, and that is the question of dosage; but this hardly comes within the scope of this chapter.

CHAPTER FIVE

HIGH CANDLE-POWER INCANDESCENT LIGHT



(FIG. 10.) HIGH CANDLE-POWER INCANDESCENT LIGHT.

OVER thirty years ago I was using a high candle-power incandescent lamp of 500 candle-power, and the same lamp is in use to-day. It was manufactured in Chicago and called the Leucodescent lamp. It is a very simple affair, being nothing more than a lamp globe (C) with a carbon filament

carrying 12-15 amperes of current. It is surrounded by a brightly polished metal hood (B), the whole being swung on an iron bracket (E) and having a counter weight (A), so that easy movement in any direction is readily applied. The apparatus is completed with a plug (D) for connecting with the main current.

Owing to the increasing difficulty of obtaining carbon filament lamps, the more modern metallic filament lamp, 1,000-1,500 watt, has to some extent replaced the older type.

One more point in the description of the lamp, and that an important one, is that there must be one single filament lamp and not several smaller lamps which in the aggregate give the same candle-power. The quality of the light varies with the intensity of the producing force whilst the heat emitted is always the same in quality, varying only in amount. The average wave-length of the light varies with the current strength; as this increases, there is an increase in the luminous rays, partly in the yellow-green frequencies; but even with a greater increase in the blue-indigo-violet frequencies, these frequencies are not increased in direct proportion to the amperage, but the increase is by arithmetic progression. The practical point of this is, that a cluster of small lights, giving 500 or 5,000 candle-power, will not produce the therapeutic effect of the single filament lamp giving the same candle-power, but using the larger amperage. With the cluster thermic rays may be produced, and with this production some measure of therapeutic good may be obtained (and as will be seen they have their place in light therapy); but where these

lamps, or clusters of lamps, are deprived of this thermic energy, their effect is nil. Phototherapy, in contradistinction to thermotherapy, means the presence of yellow-green and blue-indigo-violet rays, and to obtain these a large amperage must pass through the filament. It is a little difficult to understand if this be so, why the therapeutic effects from the metal filament lamps, with its comparatively low amperage, are so similar to those obtained from the old carbon filament lamp. The probable reason is that the metal filament emits a greater proportion of the blue and violet rays than does the carbon filament.

There are two methods of using the incandescent light. In both cases the light must be applied directly to the skin and as close to the bare surface as the patient will tolerate; little good can be accomplished if the light be applied with a garment intervening, however diaphanous that garment may be. In the one method the lamp and patient are stationary—the distance between them depends a good deal upon the toleration of the patient, and this toleration in its turn will vary with the severity of the pain which causes the patient to seek relief, and with other modifying conditions.

The other method of applying the lamp is to sway it slowly backwards and forwards (an automatic swinging apparatus is on the market, which relieves the operator of the work hitherto involved in the manipulation of the lamp) over the affected part. Here, too, the distance is a matter of judgment in each individual case, though it will naturally be very much less than in the case of the stationary treatment.

The application is not painful, though the heat from the lamp is apt to become unpleasant. This may be obviated by immediately swinging the light away on the first complaint of the patient, or by brushing with the hand that part of the surface which is being treated.

The number of applications, their frequency, and the duration of the whole treatment depends so much upon the amount of pathological change present in each individual case that no time-limit can be laid down. The average duration of each treatment is twenty minutes. It is advantageous at the end of the first ten minutes' treatment to give an interval of one minute. At the end of the treatment the skin should show a well-defined mottled erythema, which will persist for from two to three hours. Should the skin not be sufficiently reddened, the treatment may be prolonged for a further period of five or ten minutes.

In cases of pain, if the pain can be relieved and held in check by one daily application until it disappear entirely, then daily applications are indicated. In some cases, however, at the beginning the applications may have to be twice daily, but in others thrice weekly will sometimes suffice. A case of simple acute lumbago may be expected to clear up in a few days, while a case of sciatica of years' standing may take several weeks. As a general rule, the longer the duration of the complaint has been, the longer will it be necessary to continue the treatment—i.e. the longer it will be before the pathological condition which is causing the trouble will be replaced by the physiological healthy state.

There should be no sense of fatigue or depression

following an exhibition of the rays. For this reason, the first application should be of less power —i.e. the lamp farther away—and should be of shorter duration than the full therapeutic dose. Careful attention to effects produced soon determines the dosage in the individual case, but fatigue or weariness after treatment is the reaction of over-stimulation, and is an indication of too long an exposure. The length of treatment may be from ten minutes to half an hour. In general, a short, sharp application of the light is better than the longer application at a greater distance.

The theory of the curative power of sunlight or of concentrated artificial light is not thoroughly understood. Some effects are obvious, such as the dilation of the cutaneous vessels and the stimulation of the sweat glands. The deeper action may be due partly to this (for with the filling of the capillaries a depletion of other vessels must follow) and partly due to the resistance to the light energy. It is well known that, whenever energy meets resistance at any point, heat is generated at that point, cf. the heat generated by a bradawl or gimlet boring into a plank of wood. Now the skin is a poor conductor of the heat, but it readily transmits light. This light in the deeper tissues meets resistance, otherwise it would be transmitted through the whole body; and it is, I think, at the various points of absorption that the light rays are transformed into heat energy. Photographic negatives have been made showing the action of these rays on a plate through the chest and abdomen of a girl weighing 7 stone 1 lb., and others showing a penetration of 2 inches through soft tissues.

Apart from theory, clinical results obtained by the use of a high candle-power lamp would point to a deep penetration. Cases of nervous dyspepsia with flatulence are readily improved. In one case, I remember, a patient who was suffering from this disorder had had insomnia for several weeks, which was caused by the flatulent dyspepsia. After two or three applications of the light the patient was sleeping well, and shortly afterwards the flatulence had ceased to trouble him. There must have been penetration deeper than merely through the skin, to have influenced the chemical action in the stomach, which was giving rise to the fermentation and flatulence, unless it may be argued that the dilatation of the superficial vessels relieved a congestion of the deeper parts, and so a better state of metabolism was promoted.

The physical effects of this form of phototherapy are pronounced and emphatic. They are due to three forms of energy:—

Radiant Heat,
Light Rays,
Chemical Rays,

and may be thus summarized:—

(1) Dilatation of superficial vessels and glands.

(2) Removal of venous stasis and promotion of normal circulation.

And as a practical result of these principles we get:—

(1) Relief of pain.

(2) Restoration of functional activity both in the skin and in the deeper tissues.

It will be easily seen how broad a field there is for the clinical application of the high candle-

power lamp, and how many indications there are for its use.

In the treatment of some skin diseases, notably acne, chronic eczema, psoriasis, tinea sycosis, syphilitic and other ulcers, I have found this succeed where other treatment has only yielded disappointing results. In pruritus the itching is often relieved from the first application.

The treatment of acne by this light is invariably followed by good results.

There are other forms of light, as will be seen later in the chapter on skin diseases, which are more efficacious though requiring more skill and experience.

In the relief of pain I think that this form of treatment stands pre-eminent in the armament of the modern electro-therapeutist. I venture to assert that where, after a scientifically applied exposure to this light, no relief is obtained, it may be taken that the case should be promptly referred to the surgeon. And there are some cases where the light will cause the pain to become more acute; this differentiates those cases of retained, walled-in pus which call for immediate operative interference.

The cases of pain which are more particularly benefited are rheumatic and rheumatoid disease, sciatica and other forms of neuritis, lumbago and the varying conditions which are classed under the generic term "fibrositis," and certain functional diseases of the digestive system, especially gastric irritability and pain.

In certain classes of neurasthenia and insomnia, the light passed up and down the spine for ten or twelve minutes, and then applied for a similar

period to the abdomen, will produce relief, and eventually a cessation of all symptoms. In these cases a very good effect is obtained if a rather intense application of the light be made to the length of the spine, up and down for two or three minutes, and then the skin be rubbed with a flat piece of ice, five or six times, the skin then dried, and the whole process repeated for fifteen minutes. This should be done preferably one hour before the patient retires to rest. The effect is calming and soothing, and a restful night will often ensue.

In addition to its power of aiding in the cure of furunculosis and obstinate acne, the light will, in many cases, abort a bubo or carbuncle if applied before the pus has formed in any great quantity. In these cases it is a great aid as a diagnostic agent, for if the pain be relieved within ten or twenty minutes, it may be taken that repeated applications will effect a cure; whereas if the pain becomes worse —and this will occur in the first few minutes—it is certain that nothing but the surgeon's knife will relieve the condition.

If the lamp be held by the patient in his two hands and the face turned slowly from side to side directly in front of it, a common cold may be aborted if the treatment be applied early. The applications of the light should last about fifteen to twenty minutes, and be repeated, if possible, in an hour's time. The insertion of the blue filter is said to enhance the effect to a considerable extent.

The lamp is useful in painful scars, though great care must be exercised, since this tissue is very apt to blister. This is by no means the treatment of choice when dealing with painful scars. X-rays

have a far greater effect and are of much greater service, but X-rays are not always available.

There are many other cases that will suggest themselves as being suitable for this method of treatment. Cases of congested liver will improve owing to the restoration to that organ of a better circulation. Atrophied glands and muscles under the nutritional effect of the rays gain in size and function.

But I should like to mention, with much diffidence, two other classes of case in which I have obtained definite and satisfactory results. The first of these comprises certain abdominal pains, sometimes ill-defined and indefinite, and sometimes more distinct and localised pain over the region of the appendix. These I have known to yield in a most surprising manner when this lamp is carefully used; and I believe that there have been certain cases of incipient appendicitis which I have aborted by the early use of this light.

The second class of case, of which I speak with even more hesitation, is that of either the early or recurrent pleurisy. Of this I have only had two cases, but in each of these two the improvement was most marked and the breathing became easier in the first half-hour, and in both cases the trouble entirely cleared up without the patient having to go to bed, and so far as I know there has been no relapse.

Fresh uses for the high candle-power lamp are being discovered from time to time. Light aids, by a very natural process, the action and favourable results of other therapeutic measures. As an adjunct to other forms of treatment it has proved most

useful, and the statement has been made—and it is one in which I am inclined to concur—that if one had to rely upon one agent only in physiotherapy and exclude all others, the agent of choice would be high candle-power incandescent light.

CHAPTER SIX

LOW CANDLE-POWER INCANDESCENT LIGHT

As has been stated in the previous chapter, groups of small lamps, i.e. low candle-power, say 500 or 1,000 candle-power, have not the same therapeutic effect as has one large high candle-power lamp with a single filament of the same candle-power. But although the effect is not the same, yet such groups have their place, and a very definite and distinct place, and use in light therapy. Their effect is thermic rather than phototherapeutic, and they may owe the good results which they produce to the red and infra-red rays which are discussed later. One of the most useful ways in which these clusters of lamps can be used is the Incandescent Light Bath. The chief effect of this bath is to induce perspiration, and although the effects of the low candle-power lamp be due more to their heat than their light rays, yet these latter must come into the picture in some way, since perspiration is more rapidly produced in an incandescent light bath than in a vapour or Turkish bath at the same temperature.

The importance of a well-acting skin can hardly be over-estimated, and to those who are unable to get their skin to act naturally by means of physical exertion, the light bath comes as a most salutary substitute. The escape of water and salts from the skin is of great importance, not only in eliminating poisonous material which, if retained, will surely give rise to disease, but when the perspiration is checked, the respiratory and intestinal mucous membranes

get overworked and tend to become diseased. There come feelings of indigestion, a tendency to "catch cold," "rheumatic" aches and pains, all of which may be traced back to the defective skin elimination.

Among the advantages of a light bath is the stimulating action of the light rays which induce a perspiration at a comparatively low temperature; 140° F. is quite sufficient, which is, of course, much lower than the heat of a Turkish or vapour bath. The fact that the head of the patient is outside the bath enables him to be always breathing fresh air, as a consequence of which the heart and lungs are not affected as in a Turkish bath; also, the bath is individual to each patient, there being several switches, so that the requisite quantity of heat can be readily adjusted and obtained.

Where possible I advise the installation of a light cabinet in the patient's house : to the gouty, the rheumatic, the overworked, the sedentary, it is almost a necessity, and to practically everyone it is a luxury which militates against the chances of ill-health, and may be regarded as a premium paid on a policy of health.

The full light bath which I have found most useful is a cabinet measuring 5 ft. in height and 4 ft. in width. It is octagonal in shape, and has forty-two incandescent lamps of 32 candle-power each ; carbon filament, set in vertical rows, seven in a row, the lining of the cabinet being of some white polished material. This is preferable to looking-glass. The cabinet would be provided with a stool which can be raised or lowered to suit the convenience of patients of varying heights. It should be

easily opened at the top, and there should be an aperture for the neck, so that the head shall be outside the cabinet. The wood should be kiln-dried (oak for preference), so that it may not warp with heating.

A bath which is arranged for the patient to be in a sitting position, rather than reclining on a couch, is preferable for two reasons; one is that after a bath the patient may feel a tendency to faint on rising from the lying to the standing position, and secondly, that should any tendency towards fainting occur, it will be more readily noticed by the patient and the bath stopped, whereas when lying down, what might be only a tendency in the sitting posture might actually be converted into a syncopal attack not noticed by the patient and allowed to continue.

The patient should sit on the stool with the bath closed up, and, of course, be uncovered. If he be covered with even a sheet of thin material, the effect of the light rays is in some measure lost.

The lamps should be of the blue glass, not white glass dipped, if the patient is going to continue the bath for some time, for I have observed that the blue lights are more sedative, while the ordinary white lights tend to produce irritability and other nervous symptoms.

A free perspiration is usually produced in about ten minutes or less, the thermometer reading 140° F. In the majority of people, the same time spent in a room of a Turkish bath at that temperature would fail to produce perspiration, so that there is little doubt that the light rays have a stimulating effect upon the sweat glands.

The mistake that is often made when giving a patient a light bath is that he is kept in it too long; frequently patients say that they were kept in twenty to twenty-five minutes, and felt utterly exhausted after it. There should be no exhaustion after a properly given light bath treatment; rather a sense of well-being and exhilaration, so that, taken after a hard day's work, the effect should be to banish fatigue and to make the patient feel that he could do another day's work, or be able to go out and enjoy his evening.

The time spent in the light bath should rarely exceed ten or twelve minutes, and is often less, the criterion being the first drop of perspiration which rolls to the floor. This should be a sign for the patient to get out of the cabinet and into a bath of water, the temperature of which depends very much on what the patient has been in the habit of using, 65° F. to 80° F. or 85° F. If the patient has been in the habit of taking cold baths, then let the bath following the light bath be a cold one; the effect is then at its maximum. But when the patient is unused to anything but hot water, then let the bath be 80° F. or 85° F., after which he should dry and dress slowly (slowly to avoid perspiration breaking out again). There is no need to rest and no danger of catching cold; in fact, taking these baths seems almost a preventive against catching cold.

If the patient knows that he suffers from an unusually dry skin, and perspiration is provoked with difficulty, he may have a glass of hot water immediately prior to entering the cabinet, and place his feet in a foot-bath of the same.

It will add much to his comfort if a cold wet towel be placed on the patient's head, or if it be kept cool by means of a Leiter's coil. These are made of aluminium or rubber; either material is convenient.

The chief use of the light bath is as an eliminant; for the permanent reduction of weight, for instance, the use of it is futile. One pound, or even more, it is true, may be lost by the patient while in the bath; but the next day, or in a few days at the most, the patient will have returned to his former weight.

In cases of high arterial tension, the value of the full body light bath is second only to treatment by auto-condensation, one authority (Faught) even preferring it. He says: "In the hypertension accompanying acute nephritis, with the usual symptoms, I have seen great benefit follow a properly given electric-light bath, the temperature being allowed to rise in the cabinet to 125° F., to be maintained for from fifteen to twenty minutes. Under these circumstances an immediate fall in pressure occurs, often amounting to from 15 to 30 mm., occasionally more, and this fall is usually lasting in character, often persisting for twenty-four hours. The effect upon the patient is always most satisfactory, the subjective signs immediately disappearing. Elimination is increased while the pathological elements in the urine are diminished."

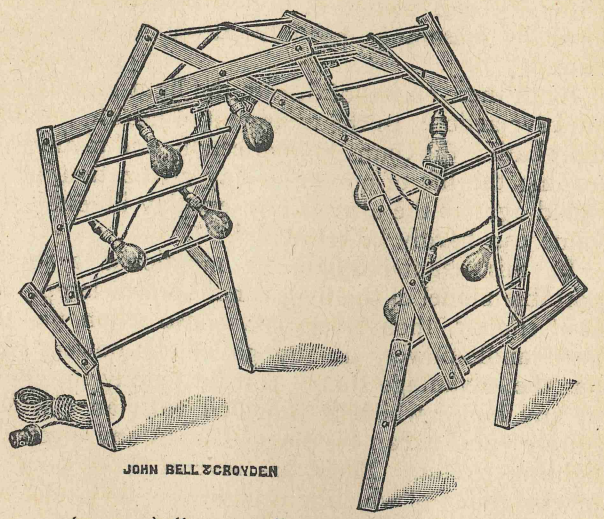
These results are probably due to the eliminating effects of the bath, and it is as an eliminant that the light bath is of great value; in such cases where prolonged perspiration cannot be employed without risk, e.g. in some cases of cardiac disease, diabetes or chronic nephritis; in auto-infection of chronic

dyspepsia and constipation; in the toxæmias of those patients who are being poisoned with the toxins of fatigue either physical or mental; in the chronic toxæmia of chronic rheumatism, when the elevation of temperature stimulates the oxidation of proteid material, and the increased skin activity carries away the waste products, in the case of patients prone to gout, or to headache due to some form of poisoning, possibly alcoholic, acute or chronic.

In all these classes of disease the light bath has a curative action. In the treatment of health, a daily light bath is the counsel of perfection, and to anyone leading the life of our latter-day civilization, as a shield against the attacks of every-day illnesses, its value can hardly be estimated.

In this chapter might be mentioned a small portable model of the high candle-power lamp. It is of similar, though simpler, construction but of low candle-power, usually 50 candle-power. It has the advantage that it can be readily installed in any house which is provided with an electric supply—and it can be plugged in to any electric-lighting circuit. There are several types on the market, none of which is expensive. Being not so powerful as its progenitor, the application has to be of longer duration. Its chief use is to allay pain. It may be applied at a distance of 24 inches for half an hour to an hour. These figures are capable of wide variation since the skin susceptibility of different patients varies enormously. In cases of earache and mumps I have found the wellnigh continuous application of these small lamps attended with signal success.

Another use for this light (and indeed the larger one may be employed if available) is a prelude to, or a preparatory means of, other forms of treatment. Administered immediately before certain electrical treatments, it would seem that it not only adds to the comfort of the patient, but it enables a stronger current to be administered without discomfort, and



(FIG. 11.) "ARNOLD" FOLDING LIGHT BATH.

thus obtain a more permanent and satisfactory result. Used in conjunction with the vacuum tubes (violet-ray), it would seem to enhance their value in certain skin affections. In 1911 a paper was read before the annual meeting of the British Medical Association by Dr. Bailey, of the Sussex County Hospital, Brighton, on the use of a lamp in con-

junction with ionization, and the very successful results he had obtained in cases of fibrotic deposits, thickening in or round joints, chronic rheumatism and rheumatoid arthritis.

Another form of the administration of the low candle-power therapy is by the small local light bath. These baths are used chiefly in the treatment of individual joints. These baths are usually cylindrical, semi-cylindrical or oblong in shape. Each is fitted with 3, 6 or 9-16 candle-power carbon filament lamps, arranged with switches so that the number of lamps required may be brought into action. The two most usual sizes are—

The trunk bath: 23 in. long, 23 in. broad, and 16 in. high.

The arm bath: 24 in. long, 18 in. broad, and 16 in. high.

The part to be treated should be placed uncovered in the bath, and carefully inspected to see that it is nowhere too near any lamp. Then the whole bath may be covered with a thick blanket which will serve to close the ends of the bath. The average duration of treatment is fifteen minutes to half an hour. There are special radiant heat baths, of a smaller size, made for the shoulder ; but it is better to use an arm bath, for when the bath is small, the liability to accidental burns is much increased.

Lastly, there is a variety of low candle-power light therapy introduced by Dr. Virgil Kinney of New York some ten years ago. This consists of local and general application of low candle-power light and heat over prolonged periods of time—for example, three to twenty-four hours—either by means of specially constructed hoods attached to the

part by the patient or the attendant, or by the general application of low candle-power light over the patient's whole body by means of a single hood, the intensity of the light and heat in both cases being low enough to prevent any injuries to the tissues.

CHAPTER SEVEN

SUNLIGHT AND SKIN DISEASES

ARTIFICIAL sunlight or ultra-violet radiation is one of the most useful adjuncts in the treatment of diseases of the skin. In these, more than in any other class of disease, has it been used and found of the greatest service, and when used with ordinary care and intelligence is incapable of producing permanent harm.

It must not, however, be taken that the rays, say, from portable apparatus, are to be directed on the affected part and that a cure will be the immediate and certain result. It must be premised that many dermatological conditions are only the outward and visible signs of causes essentially internal, and the internal action of ultra-violet radiation, which far exceeds the external action in importance. For instance, the condition which is evidenced by baldness and falling or greying hair, is due, in a great measure, at any rate, to the failing function of the glands of internal secretion. Now the rays which are employed for the treatment of the scalp have a powerful stimulating effect upon these endocrine glands which determine the conditions of the various organs and tissues and body functions, and so to regard the local action only, is to miss the point and to evince the same want of grasp of the fundamental principles of ultra-violet therapy as was shown in a recent report of the Medical Research Council, which compared the action of these rays with that of a mustard plaster, rather to the detriment of the former. The treatment of falling

hair and baldness up to twenty years ago was unsatisfactory in the extreme; in fact, by many authorities stated to be useless. This was due to the fact that it was looked upon as an external ailment due to external causes and the treatment confined to external remedies. Now that actinotherapy is becoming better known, and the internal causative of the trouble is realized, the powerful remedial action of ultra-violet therapy is brought to bear, and favourable results are being obtained by its use not so much by its local action on the scalp and hair follicles as by influencing those inner glandular processes which are the cause of the hair turning grey or falling out.

Hair does not fall out because of old age—old age is not a disease—it is rather a condition brought about by the lessening function of the endocrine glands, and this weakening is not old age, *per se*. It may often accompany people who are advancing in years, but not because they have spent a certain number of years in this world, but because in those years they have accumulated a certain quantity of poisons in the body which have poisoned or aged those glands. The poisoning or ageing of these glands manifests itself in the outward signs of what we call old age, grey or falling hair, for example. But when we use an agent which can stimulate or rejuvenate those glands it is only logical to suppose that the body in general, and those parts in particular, which have suffered from that poisoning will show signs of regeneration or rejuvenation, *pari passu*, as the glands themselves are rejuvenated. It may appear that I have digressed somewhat from the title of this chapter, but I have

done so in order to impress at the outset that the action of sunlight on skin diseases is not confined to the comparatively insignificant effect upon skin alone, although its local effects may be more manifest in some skin diseases, and notably so in the condition of alopecia. That good results have been and are being obtained in this respect, will be seen later, and for fuller evidence the reader is referred to various works on the subject. The French claim to have raised a full crop of hair on a head which was formerly as bald as a knee (chauve comme un genou). Turrell in his book[1] shows illustrations confirming this. Nagelschmidt bears out this statement,[2] and Lorand has written a book[3] which bears the sub-title: "The use of ultra-violet radiation in preventing loss of colour and falling of the hair."

In the United States, too, medical literature makes ample reference to this subject, but to come to ultra-violet light and its treatment of skin diseases, pride of place must be given to the treatment of lupus, which was begun by Finsen (the pioneer of artificial sunlight treatment) in Copenhagen, and in English hospital work by Sequeira, though (I have it on the authority of Dr. Ernest Dore) the late Malcolm Morris was actually the first to introduce it into this country, and in 1907, in conjunction with Dr. Dore, published a book entitled *Light and X-Ray Treatment of Skin Diseases*.

It is true that at first Finsen used the sun as a

[1] *Principles of Electro Therapy*, by Turrell. Second Edition, 1929.
[2] *Die Lichtblehandung des Haarausfalles*, by Nagelschmidt. Second edition. Berlin, 1919.
[3] *The Ultra-violet Rays*, by Arnold Lorand.

source of light, but soon found that if there were to be any continuity in the treatment, it would be necessary to use artificial light. He chose for his source the carbon arc, as this, in its properties and composition comes nearest to the light of the sun, since it has an almost continuous spectrum. Later, Finsen used the carbon arc light even in preference to the sun itself, because he found that it contained more ultra-violet rays than did sunlight, in which so many of the ultra-violet rays are absorbed by the atmosphere.

Probably more cases of lupus have been treated by ultra-violet radiation than all other skin diseases together, yet there is a great variety of the latter, in which these rays can be profitably employed, and the reason of this may be seen in a sentence of Crocker's,[1] in which he states that the keynote of modern dermotherapeutics is antisepticism, and, as every surface which is bathed in ultra-violet radiation is rendered aseptic, one reason for its efficacy in a great variety of skin diseases is made plain.

Another reason why so many skin diseases can be treated to advantage with ultra-violet radiation is the fact, already mentioned, that the skin becomes fluorescent when exposed to its influence. This fluorescence has, too, a practical value for dermatologists in diagnosis. Pigment spots and depigmented areas are rendered more noticeable, and a difference in the pigment content can be distinguished which would escape observation with ordinary illumination. Not only is the filtered

[1] *Diseases of the Skin*, by Radcliffe Crocker (1913 edition).

ultra-violet radiation useful in the examination of pigment anomalies, but it is of assistance in the diagnosis of most dermatoses accompanied by changes of the corneum.

The filtered light is particularly suitable for the examination of X-ray effects on the skin. Radiodermatitis on the hands of Roentgenologists may often be discovered earlier by changes of the pigment content and disturbances of the corneum.[1]

Psoriasis gives a silver white light, and a pink fluorescence may shine through from the underside of the scales. The examination of eczema is useful in apparently healed foci; in filtered light such places are distinguished from the surrounding parts by strong fluorescence. Fungoid diseases, foci of tricophyton and microsporon of the hairy part of the head show a greenish fluorescence.

In ringworm the use of ultra-violet light is extremely valuable in diagnosis, as a single hair which is attacked by the fungus shows an intensely bright metallic green when the ray filtered through a dark filter is thrown upon it. By this means an early case, or a case apparently cured, can be diagnosed in a moment instead of a long time being spent in searching for affected hairs.

Turning, however, to the great variety of skin diseases in which ultra-violet radiation may with such great advantage be employed, and in which to-day it cannot be ignored, perhaps it might be more usual and scientific to classify these either in order of their importance or according to their development; but, for one who lays no claim to

[1] S. Bommer, *Klinische Wochenschrift*, June 11, 1927.

be a dermatologist, it will be more expedient to enumerate them in alphabetical order.

In most skin diseases nearly a 50 per cent. advantage is given if general irradiation be added to the local treatment, when there is not only the germicidal and other local action, but the general building up of resistance, which has been found to have increased, by half as much again, the probability of success.

As to dosage in the treatment of dermatological conditions, at the seat of the lesion there must be produced a definite local reaction; a second or third erythema dose must be given if success is to be obtained. This rule is of well-nigh universal application to all skin diseases.

ACNE

This subject is one which has for many years interested dermatologists and doctors before the days of dermatology as a speciality, and few skin diseases have been attacked by so many methods as has acne. But it will be noted that the aim of most of the local treatments has been the production of a hyperæmia, and never before has there been a more safe and satisfactory method of producing a hyperæmic condition than by the use of ultra-violet rays.

Obstinate cases of acne, whether on the face, or the neck, or the back, especially in those patients who have a pale and oily skin, lend themselves readily to treatment by the ultra-violet radiation. Although I know that the X-ray is the court of last resort, it is not always possible to appeal to it. For one thing, it is essential that the physician

should be a skilled radiotherapist if he is to apply X-rays to the face with safety and success. In the case of ultra-violet rays there is no such handicap, for nothing but negligence on the part of the physician can cause any permanent damage to the cutaneous surface treated by the light. To bring about permanent relief, the usual remedial agents, both internal and external, should not be neglected; otherwise a recurrence of the trouble is almost inevitable.

It is needless to remind the practitioner that, in addition to the local condition, primarily due to bacillary infection, there is often also some general condition, anæmia, constipation, poor circulation, or a general lack of tone, which must receive attention; and it often happens that for this the general body treatment with the carbon arc is of great service.

There is also the antiseptic effect on the entire region which is irradiated, so that the whole skin is placed in a more healthy condition.

As to technique, any comedones which may be present should be expressed. A general irradiation of the face, back, neck, or whatever part be affected, up to a second degree erythema, should be given. Single individual pustules may be treated with the Kromayer lamp in contact; in the early stages the pustules will be aborted, and at any stage of purulence an application of the short bactericidal rays will limit the pus formation and any subsequent scarring. In the so-called "bromide rash," the general body bath, given so as to produce a definite erythema, will be found very efficacious.

ALOPECIA

General alopecia differs in the male from that in the female, not only in character but in the fact that it is more difficult, probably owing to the nature of its distribution in the female, to get results with ultra-violet radiation. With the hyperæmia the nutrition of the scalp is improved, and whatever the cause of the baldness may be it connotes some disturbance of the nutrition of the scalp. It cannot be said that the treatment of alopecia of the ordinary type by ultra-violet radiation has been attended by very brilliant results, but I have had many cases showing definite improvement, especially in the premature alopecia of men, and when it was not hereditary. Undoubtedly, ultra-violet radiation has an action, by producing hyperæmia of the scalp, of stimulating the growth of the hair. It is a matter of considerable difficulty to know how to advise a patient when he asks whether or not he shall continue the treatment; but I take as a guide the daily loss.

Either the air-cooled lamp or the Kromayer may be used, whichever is the more suitable for the size of the denuded area. Each treatment should be of sufficient duration to produce a definite erythema. When treating the female scalp, a certain part, or furrow, should be selected for treatment, and the hair brushed away from this on either side.

When there is general alopecia, not less than half the scalp should be irradiated at each sitting. The patient should be warned that redness and soreness will follow, and that desquamation usually occurs on the fourth or fifth day. In cases of recent alopecia, especially those of infective origin, hair

rapidly appears; it may come in a very light shade, perhaps white in colour, but this will almost always darken if a few (six or seven usually) more treatments are given.

In the treatment of alopecia areata a much more favourable prognosis may be given, especially in those cases of recent development where no extensive atrophy of the follicles has occurred. Of these cases it may be said that they invariably clear up under ultra-violet radiation.

BOILS AND CARBUNCLES

The pathology and treatment of these two conditions being so closely allied, they may be taken together. Either of them is invariably an expression of not only local, but general lowered resistance. This provides the key to the treatment. The local lowered resistance has allowed the staphylococci to grow and multiply, and this should be treated locally with the bactericidal short rays of the water-cooled lamp, and the lowered tone of the general system be raised by the general irradiation of the whole body. Locally, a third degree erythema should be produced with the lamp in contact, not only with the actual area occupied by the boil, or carbuncle, but with an area of about an inch of the skin surrounding it.

CHILBLAINS

A chilblain is essentially an erythema occurring in patients with poor peripheral circulation and a disturbed vasomotor tone. The good results from the use of ultra-violet rays in this disease are probably due to their direct effect on the peripheral

vessels and blood stream. The rays are not only of value in curing the lesion, but if used sufficiently early in those who have had previous attacks they may prevent a recurrence. The same may be said of the treatment by the melted paraffin-wax bath, which I have been using for the treatment of chilblains since 1918. Occasionally I have found a case more prolonged in its course or more rebellious to the treatment than usual. Then I added to the melted paraffin-wax bath ultra-violet radiation, when the chilblains invariably cleared up, however severe, persistent, and obstinate they had been before.

The result is surprisingly good, the irritation is rapidly calmed, desquamation frequently follows, and the fingers or toes resume their normal appearance.

The severity of the conditions does not appear to affect the results except favourably. Certain it is that the worse the condition the more striking the results. Cases have varied from a condition of slight blotchy redness with irritation to those in which there have been deep, raw cracks and fissures in the front of the fingers, and ulceration on the back of the hands. Naturally, the more severe the case the longer the time needed to attain a return to the normal; but improvement will begin with the treatment, and applications of the rays spread over a period of from two or three weeks will usually be found to be sufficient. In cases where the skin is broken, a combination of ultra-violet with infra-red radiation accelerates the return to the normal. In cases of ulcerated chilblains the results are remarkably good.

ECZEMA

This constitutes about one quarter of all skin diseases, either complicating the clinical picture of their dermatological conditions or appearing of itself in its many protean manifestations. So varied are these that it is impossible to lay down the treatment by ultra-violet radiation with any degree of precision. But speaking in broad generalities the dry, scaly forms should be treated by the water-cooled lamp in contact with the skin, while for the subacute weeping types more sedative rays from the air-cooled lamp, or the carbon arc, should be used at a long distance, and the very acute cases should not be treated at all by any form of ultra-violet radiation. Those eczematous legs, which although having no definite ulcer continue to discharge and are a source of endless trouble, clear up after the irritation caused by the erythema has died away. The chronic indurated types require more severe doses than the subacute conditions. All dried and caked secretions, crusts and scabs, must be removed prior to raying. A 10 per cent. solution of hydrogen peroxide is useful for cleansing purposes, and is said to have the property of intensifying the action of the rays; all ointments should be avoided as far as possible during the treatment—a simple wet dressing, or one of sterilized vaseline, being all that is needed.

HERPES

All varies of herpes or *shingles* derive benefit from ultra-violet light treatment.

Until quite recently this was considered a disease which obstinately resisted treatment, and often

the best that could be done in severe cases was to give a hypodermic injection of morphine to relieve the pain. Now much assistance can be given to the patient in all forms of this condition, and relief afforded not only from the severity of the eruption, but from the accompanying pains. In fact, if seen early enough little or no pain is experienced after the first treatment. *The earlier in the case the ultra-violet light can be administered the more marked is the benefit derived from it.* Radiation will often arrest the development of the vesicles, and they will dry up and leave little or no scarring. Even when the eruption affects the ophthalmic division of the fifth nerve which supplies the face, where scarring and severe scarring is the rule, the duration of the disease is greatly lessened by the application of ultra-violet radiation. Given then, ultra-violet radiation with correct technique, the eruption will be aborted and pain relieved, and the end results reduced to a minimum. The treatment of herpes by ultra-violet radiation is spectacular in its success.

IMPETIGO

The short bactericidal rays from the Kromayer lamp are indicated in impetigo, and a certain degree of erythema should be produced. If necessary, when the erythema subsides, treatment should be repeated, and it must be remembered that ultra-violet rays will not penetrate the scabs or crusts which cover the lesion. Before applying the ultra-violet light every trace of crust and every over-hanging blister-margin must be removed. The best and most simple way of doing this is by prolonged and frequent bathing or dabbing with cotton-wool

soaked in hot water or a solution of hydrogen peroxide. The patient is instructed to mop off the crusts by bathing the affected part half an hour two or three times a day. At the time of treatment all crusts must be carefully wiped off with wool or picked off gently with a pair of forceps. When this is done, and not before, the ultra-violet light is applied.

LUPUS

This is a fairly common disease in this country, being estimated at 2 per cent. of all the skin cases seeking relief at the various skin hospitals. In its treatment the utility of ultra-violet radiation, as introduced by Finsen, is beyond the realm of controversy and rests on accepted and established fact. Dr. Sequeira's monumental work at the London Hospital is too well known to need any mention here. For nearly a quarter of a century he has been using ultra-violet radiation patiently and persistently, and testifies with characteristic scientific reserve that the results " continue to be of a highly satisfactory character." Reference should be made to the various communications of Dr. Sequeira.[1]

Two points, however, must be mentioned, one is that there are certain forms of lupus which are not suitable for treatment by ultra-violet radiation; and the other point is that when the nude body and limbs are exposed to ultra-violet radiation in

1 "Seven Years' Experience of the Finsen Treatment," *The Lancet*, March 7, 1908; "The Finsen Light Treatment at the London Hospital, 1903/13," *The Lancet*, June 14, 1913; "Treatment of Cutaneous Tuberculosis," *The British Medical Journal*, September 22, 1923.

addition to the local application, the percentage of cures is considerably higher, and many cases which have failed to respond to local treatment immediately show improvement when the general body bath is added.

It has often been said that there is no royal road to success in the treatment of lupus. But it would seem that ultra-violet rays are lighting up a road which, if it be not a royal road of success, may well be an avenue leading to it.

PSORIASIS

Considering the obstinate nature and the chronic and recurrent course of this disease, its depressing effect on the patient can be readily understood. In comparison with disagreeable applications he will welcome a remedy both painless and clean, especially one that will not interfere with his occupation and is free from remote ill-effects.

The type of psoriasis which yields the better results is that in which the disease affects the classical situations, elbows and knees, and is of the more localized and infiltrated type, rather than the superficial and widespread type of psoriasis.

It is very reasonable to expect improvement in cases of psoriasis when treated with the ultra-violet light, for the comparative immunity of the exposed parts is probably due to the action of light normally occurring on them.

The preparation of the patient with psoriasis has much to do with the successful treatment of it. All traces of ointments, layers of powder, scales, etc., must be removed before the application of the light. The counsel of perfection is that the

application by contact should be made to each individual plaque of the psoriasis. For the subsequent irritation, a simple dusting powder, without any greasy application, will help to prevent pain or discomfort from friction of the clothes.

The manner in which patches of psoriasis which are not exposed to the light will clear up when parts of the body far removed from them are irradiated has been mentioned already when dealing with the indirect action of light.

PRURITUS

Although the intense irritation of this distressing state is of itself sufficiently troublesome to justify its inclusion in this list of diseases, a note was but recently made[1] which gives to this condition a grave significance. The note is to the effect that pruritus may be a prodromal symptom of malignant growth, as it is encountered not only in the cachectic stage or in association with jaundice, but in the early stages when the patient is feeling quite well. The irritation in these cases may be either generalized or perineal.

The actual cause of this obstinate condition may explain why the ultra-violet radiation should have so good an effect. It has already been said that ultra-violet rays seem to exert a biologic action in the neighbourhood of the inter-epithelial nerve fibrils; but if the pruritus be caused by the *Staphylococcus albus* and the *Bacillus coli communis*, then the lethal effect of ultra-violet radiation will

[1] Epitome, *The British Medical Journal*, June 28, 1924. H. Kuttner, *Zentralbl. f. Chir.*, April 19, 1924, p. 824.

readily account for the death of these micro-organisms and the cessation of the intolerable irritation, the insistent call to scratch, and the resultant insomnia.

In this disease there may have to be some preparation of the patient. If the condition has invaded the hairy skin, all the hairs should be cut short, as each hair casts a shadow which obstructs the light. For this reason in France the skin is often shaved preparatory to any treatment by light. The parts should be thoroughly cleansed with soap and water and dried carefully. Any crusts should be removed. With the hands, in rubber gloves, if preferred, the parts should be smoothed out in order that the rays may sterilize all the folds and recesses.

Successful treatment needs infinite attention to detail and even this has to be varied according to the nature of the case, area of distribution, etc.

In pruritus vulvæ the patient should be warned that the reaction may be sufficiently severe to necessitate her staying in bed for a day or two; but her previous sufferings will usually cause her cheerfully to assent to a temporary suspension of her walking activities.

SYCOSIS OR BARBER'S ITCH

Sycosis of the beard is obstinate and difficult to eradicate, but readily succumbs when treated with the Kromayer lamp in the manner prescribed for impetigo (*q.v.*). The patient will complain of the erythema and its effects, but his complaints will be more than counterbalanced by the gratitude a few days later.

ULCERS

Chronic ulcers of various kinds include those associated with varicose veins. It is remarkable to see how, after the ulcerated surface is exposed to ultra-violet radiation, healthy granulation is established and epithelial patches begin to appear.

This concludes an astonishingly long list of skin diseases. I am not claiming either now, or when on the crest of the most optimistic wave, that the ultra-violet light will always cure all, or, indeed, any of them; but it must be pointed out that at some time or other in the last ten years, each of these diseases has been treated with the ultra-violet light, in most cases with success and in many with benefit. Furthermore, in ultra-violet light therapy we have a remedy incapable (when used with ordinary care) of inflicting injury to the skin, and a remedy, moreover, which has a rational basis from which a fabric of therapeutic benefit may be expected to arise, and, having arisen, to stand firm.

CHAPTER EIGHT

SUNLIGHT IN OTHER DISEASES

WHEN discussing the general therapeutics of ultra-violet radiation it was shown that these rays were absorbed by the skin and the superficial capillaries of the skin, and gave rise to metabolism of the patient. By no other means in our power can these alterations in the blood be induced so simply, safely and surely. It is only by a careful consideration of these changes that we can come to any conclusion as to the class of disease likely to derive benefit from treatment by ultra-violet rays. For example, anæmic conditions will benefit from the increase in the number of blood cells; rickets from the production of vitamin and calcium salts; this latter will also be a factor in the benefit obtained in surgical tuberculosis, where the increased bactericidal power of the blood is perhaps the dominant consideration. Many diseases will occur to the mind in which it must be useful to be able to give the patient the advantages of these and other properties, such as the phosphorus increase induced by ultra-violet radiation. Where we can induce an improvement in the general health, increased resistance to disease or improvement of the vasomotor tone by any agent, the indications for the use of that agent grow and multiply in the mind with extraordinary rapidity. Apart from sufferers from severe or well-defined illness, there are convalescents who are now, as a rule, advised to go to the seaside for " a change of air " and the tonic effect of the seaside. I have no wish to decry this venerable and valuable

prescription, but it is not always within the range of practical politics. Similar, but not quite identical, are those cases, both young and old, whose ailments are classed under the head of *general debility*; delicate, easily-tired, perhaps irritable, but never feeling well children or adults in whom the most careful examination by the most skilled physicians and specialists fails to reveal traces of actual disease. The fagged-out business or professional man, the over-worked, or over-playing society woman, the weak and undeveloped child with no demonstrable pathology which would indicate either surgical interference or a satisfactory prescription of medicine—these begin to flourish with ultra-violet light treatment. Under its influence the effect upon the general condition of these patients is remarkable. The irritability and fractiousness go; the appetite returns, with increase of body-weight and strength. They no longer catch colds readily, and, with the improvement in blood conditions, they feel day by day in every way brighter and better as their resistance to disease increases.

The success in the treatment of septic lesions is very gratifying. Its use in acne, in boils, and in carbuncle has already been mentioned, but attention must be drawn to the value of ultra-violet radiation in inveterate boils, and in those indeterminate streptococcal complications of other lesions which resist with much obstinacy the ordinary forms of treatment. In fact, many septic complications of many diseases are rapidly controlled by ultra-violet light.

One other important effect of ultra-violet radiation

must be mentioned, and that is the rejuvenating properties it possesses. This is no new knowledge. The sacred writings of the Hindus, written thousands of years ago, stated that the sun's rays were able to restore vigour to the muscles and brighten the intellect of the elderly.

Lorand is of the opinion that the rejuvenation is brought about by stimulation of the endocrine glands, especially the thyroid and the sexual glands, and there is now no doubt of the value of sunlight in those cases showing symptoms of glandular insufficiency. Amenorrhœa caused by ovarian insufficiency, or obesity from a similar cause, are favourably influenced by ultra-violet radiation. Thyroid insufficiency, especially in children (even those who have been treated for a long time in the recognized manner), yields to this form of treatment. Asthenic conditions due to adrenal insufficiency improve very much with the sunlight treatment, and it is a useful concomitant to the administration of almost every one of the glandular extracts. " Middle age " and glandular insufficiency are almost interchangeable terms—and if ultra-violet radiation be the treatment of the latter it is clearly indicated when symptoms of the former occur. Middle age, or any symptom of middle age, should be prevented if possible—and certainly treated as any other pathological condition, where it occurs. " We shall surely die, but must we needs grow old ? " [1] The answer is in the negative, provided always that the treatment of health be observed, and the glands perform their

[1] W. H. Henley, *Book of Verses.*

functions normally, or be stimulated to do so when their energy shows signs of flagging.

The ultra-violet radiation undoubtedly has a definite influence upon muscular agility. After even one treatment, patients usually note a disappearance of lassitude and fatigue, and they become conscious of a feeling of well-being and of a capacity to enjoy life which before the radiation they had almost forgotten. Not only is a rejuvenation of the body effected, but there is an improvement in the mental capacity. Patients will show more interest in reading " dry " matter, and find it easier to memorize what they read. Ideas flow more readily, and new powers of expression come with the other manifestations of brighter brain work.

In the alimentary system there are several diseases, or pathological conditions of the alimentary system, in which ultra-violet radiation has proved of real benefit. It has been used a great deal in hyperacidity, chronic gastritis, and gastric and duodenal troubles. Ultra-violet energy applied over the gastric region usually lessens or relieves the pain of these conditions.

Clinically, ultra-violet light often quickly relieves hyperacidity in certain miscellaneous disorders involving the secretory function of the stomach, and it is probable that the mechanism involved in this reaction plays an important part in effecting symptomatic relief in gastric ulcer. Certain it is that the pain of a gastric ulcer will sometimes clear up as quickly and as effectually as when a hypodermic injection of morphine has been given. Of course, there are other factors at work besides the lowering of the acid content. With the erythema

produced, there is an increase in the elimination of toxins, and even their production is lessened by the destruction of the bacteria producing them. As has been seen, this action can take place at some distance from the area treated, and it is due to the changed condition of the blood stream by the absorption of the ultra-violet rays and its remote effects.

Similar applications are of service in cases of congested liver or in cirrhosis of that organ. It is doubtful if any therapeutic measure effects as much good as ultra-violet therapy in diseases of the liver. The reaction produced profoundly influences the blood supply. It is of great service in the relief of chronic inflammation of the gall bladder. It allays the pain and tenderness, because it lessens the congestion. Since the erythema diverts the blood supply from the congested liver to the skin area over it, it tends to lessen the portal circulation, and is thus of use in those cases which tend to develop dropsy.

Much has been written about the effects of ultra-violet radiation upon the obese patient and its power of weight reduction. As an adjunct to electrical, dietetic and other forms of treatment it is most valuable. It not only adds to the comfort and well-being of the patient but is of material assistance in aiding the weight-reducing treatment. But ultra-violet radiation is not a therapeutic measure upon which to rely in the treatment of patients who are over weight, except, perhaps, in those cases in which the obesity can be traced definitely and decidedly to a glandular deficiency.

In the Circulatory System the action of

ultra-violet radiation is threefold. The chemical changes induced in the blood have already been mentioned. These may account for the weak hæmostatic action which it produces. It has also a definite vaso-dilator action upon the cutaneous vessels, and ultra-violet light has a decided influence upon the blood cells, multiplying their numbers, and also increases the number of blood platelets. Ultra-violet radiation—the full body bath—is of use after hæmorrhages, and even during some hæmorrhages such as the excessive loss of blood at the menopause. It will be found not only to check them and to diminish their frequency, but to improve the blood picture and the general well-being of the patient.

The use of ultra-violet radiation in chilblains has already been discussed. It has also been used in the treatment of phlebitis and varicose veins.

In the genito-urinary system ultra-violet radiation has rendered good service in the treatment of nephritis. Its beneficial effect is probably due to the hyperæmia it produces on the skin over the kidney area, which in its turn creates a secondary or subsequent hyperæmia in those organs. In certain forms of enlarged prostate ultra-violet rays afford much relief, and the necessity of frequent micturition is often relieved. It is not suggested that it is a counsel of perfection to treat enlarged prostates with ultra-violet radiation, but its use cannot be overlooked in a book on the subject, it being a condition which affects about one-third of all men over sixty years of age, and one in which medicine offers so little, and surgery only such an operation as prostatectomy.

In diseases of women ultra-violet radiation is capable of yielding very good results. In amenorrhœa, whether of puberty or of later life after menstruation has been established, ultra-violet radiation is a useful and convenient form of treatment. Disordered or absent menstruation often means some alteration of the endocrine glands, and, as has been shown, ultra-violet radiation stimulates the activity of these glands. After treatment by the carbon arc general body bath, I have seen complete restoration of the menstrual function after amenorrhœa of several months' standing, and it would seem logical to argue from this that its use in cases of sterility is indicated.

Leucorrhœa—when the origin of the discharge is not cervical but a symptom of vaginitis—may well be treated with local application of ultra-violet light.

In the Respiratory System, although it is not easy to see the rationale of the treatment, it must be admitted that ultra-violet radiation is sometimes successful in cases of asthma. I first used it and with success in 1914, upon a colleague of mine on the staff of the 3rd London General Hospital, at the suggestion of Sir Bruce Bruce-Porter, our commanding officer. At the International Congress of Radiology (1925) Sir Henry Gauvain reported a case of a lady in whom ultra-violet rays had entirely removed her asthma; and between those dates, and since, there have been cases of asthma which have shown great improvement after the patients had had ultra-violet treatment.

In simple bronchitis, the treatment improves and comforts the patient. The cough becomes less

frequent, the expectoration diminishes and the general condition is improved.

In the Nervous System ultra-violet radiation used with care and discernment produces the most successful and certain results. Whether the good effect be due to the alteration in the blood chemistry, the endocrine balance, or to the bactericidal improvement of the blood, or to all three, or to something different altogether, matters little to the patient; but certain it is, whatever may be the explanation, there are few treatments for which the neurasthenic will be so profoundly grateful as ultra-violet radiation. One advantage, and in the treatment of neurasthenia it is a double advantage, is that it involves no going away from business. The treatment should be given daily, and the patient encouraged to go on with his usual vocation. His mind then has something on which to dwell, other than his own symptoms. For few things are worse for these patients than time for introspection. Under treatment, they find day by day that they can take more interest in their work, and that, however slowly, the power of concentration gradually returns and the periods of content occur more frequently, replacing the continued depression.

Headache.—There is a peculiar, but definite type of headache, in which a remarkable improvement may be effected by artificial sunlight. The subjects, who are more frequently women than men, are of the lymphatic type, somewhat anæmic, complain of general "tiredness," and occasionally show slight œdema. The headache of which they complain is dull and heavy (occasionally throbbing), worse in the mornings, better in the evenings.

The blood shows a lowered coagulability and a lessened calcium content. Ordinary remedies give temporary relief only. Dr. Arthur P. Luff, years ago, called this "the lymphatic headache," and treated it, and with success, with calcium; so it is not surprising that with the raising of the calcium content by means of artificial sunlight, a headache due to a calcium deficiency should be cured.

Sciatica and other forms of neuritis.—The water-cooled lamp applied with a quartz lens along the length of the affected nerves will usually afford relief. The number of treatments needed for success is very variable. In cases of recent origin a few treatments usually suffice, but even old chronic cases of years' standing sometimes clear up in a surprisingly short space of time, and cases, too, which have been treated by the usually accepted methods without success.

Lumbago and other forms of muscular rheumatism.—In all probability, the symptoms recognized under this head are the outward and visible sign of one of three or more internal causative conditions. The ultra-violet light may aid—in all probability does act upon—one or more of these conditions; but there is not space in this short book to discuss these causes and the way in which ultra-violet radiation exerts its beneficent effect. Were it so, it could be shown why these cases yield to these forms of treatment; and yield they certainly do, for I have seen lumbago disappear after one irradiation, and even cases of some weeks' standing have been relieved from the first, and only needed five or six treatments to effect a return to normal.

Two other systemic diseases in which ultra-violet radiation is of special service cannot be omitted. The first of these is rickets. This disease is probably the most amenable of all diseases to sun treatment or to its artificial substitute. Its value has been proved beyond doubt. For the last twenty years medical literature teems with testimony to its value in the treatment of rickets. So much so, that it would seem superfluous to enter at length into the subject here, and to discuss it superficially would be unsatisfactory. Two reports may, however, be quoted—one by Porcelli and the other by Drs. W. Allen Daley and Kathleen Gamgee.

"Three severe cases of rickets were successfully treated with ultra-violet rays. The children were aged 8, 6, and 5 years, and were members of one family. Twenty-four applications were made at intervals of five to eight days. One child who had not walked, though 5 years old, was able to walk after six irradiations. The radiograms showed increased centres of ossification in the carpus after two months' treatment. The general condition of the children improved; they were more lively; their colour improved; and the bone tenderness disappeared."

In the Porcelli report several interesting but typical items were mentioned; among others, that the children, having been properly examined and found suitable for the artificial sunlight treatment, were placed on a waiting list and advised as to diet and general hygienic treatment which improved the health of the child in cases where the mother was persevering and intelligent. "But,"

the report goes on to say, "improvement effected in this way is far more gradual and altogether a slower process than the dramatic changes seen at the artificial sunlight clinic." The children lost their transparent, anæmic look, became livelier and at the same time more peaceful. The first improvement is usually registered by the mother, who states, of her own accord, that her baby is more active, but at the same time sleeps more and is far less trouble at home. One of the cardinal symptoms of rickets—nervous irritability—is the first to yield to artificial sunlight treatment. Another point to note is the rapidity with which the anæmia gives way to ultra-violet radiation.

I have chosen these extracts of reports from widely differing sources, as being typical of what may be expected when rickets is treated with artificial sunlight.

Before leaving the subject of rickets, its prevention by means of radiation must be mentioned.

The treatment should begin as soon as pregnancy is proved. In the parturient female an increased calcium content is a consummation most devoutly to be wished. There is normally a great drain upon her calcium metabolism, as is often evidenced by dental trouble, and, owing to this drain, the seeds of rickets may be sown in the child before ever it is born. Hence, both for her own welfare and that of her unborn child, let the expectant mother have some form of light therapy during her pregnancy. Apart from being an insurance premium against the production of unhealthy offspring, the mother will experience a sense of health and well-being not always obtaining among women labouring

with child, but which usually accompanies the administration of general light therapy.

Furthermore, treatment by light should be continued throughout the period of lactation. What better prophylactic agent against the occurrence of rickets could be desired than the maternal milk rich in calcium salts?

This is, of course, the counsel of perfection, and at the present time not practicable for the many, but it would certainly make for the prevention of rickets.

Another measure which would do much to eradicate this widespread disease of children would be the raying of every child for a month or six weeks during the first year of his life. Two or three times a week would be all that would be needed, and this would have far-reaching effects and produce results at which one could only hazard a guess, but which I venture to think would be comparable to the effect that vaccination has upon small-pox.

The prevention of rickets in the children of the nation is a national duty, and so surely as it is performed a national reward will follow in the bringing up of a population, few of whom will appear in Class C3, but who will be sturdier and stronger by the elimination of a disease which for too long has weakened and depleted several nations.

Tuberculosis.—This again is one of the few conditions about which, in connection with ultra-violet therapy, much has been written. No attempt therefore will be made here to discuss it with any degree of completeness.

Let it be understood at the outset that the counsel of perfection for the treatment of tuberculosis, as a rule, whether it manifest itself in lung or gland, in bone or skin, is to send the case to a high altitude for treatment by heliotherapy, and this, too, *as soon as the discovery of the disease is made.*

The sun cure in the high mountains is now generally admitted to be the most satisfactory method of treatment in the large majority of cases of surgical or localized tuberculosis. But it is in a foggy country like this, where the climatic conditions do not lend themselves readily to living without clothes, and where sunny mountain tops are not always available, that we must look for the next best thing, and it is in the artificial sunlight that we find it.

It must be premised as an article of faith that every case of tuberculosis should be treated with ultra-violet radiation whether this be derived from the sun or from any artificial source.

The treatment of pulmonary tuberculosis by artificial sunlight is one yet *sub judice*, while in the field of surgical tuberculosis it has attained the greatest success. It will be discussed in the chapters on Sunlight in Surgery.

There are many other medical conditions and diseases in which benefit can be obtained from ultra-violet therapy. Many of these have been perforce omitted and many more deserve fuller mention, but if enough has been said to draw further attention to the subject of ultra-violet radiation and to stimulate its further study I have not written in vain.

CHAPTER NINE

SUNLIGHT IN SURGERY

THERE is no form of treatment in surgical tuberculosis which can compare with that by sunlight. It is for this reason that this disease will have the first and principal place in this chapter. In cases of surgical tuberculosis, it is difficult to restrain one's enthusiasm when speaking of ultra-violet therapy, or to refrain from quoting cases which would read as do the miracles. Tuberculous spines and joints with discharging sinuses having lasted through years of illness, begin to improve, sometimes after the first or second treatment, and when this takes place progress is assured.

The treatment of this condition may be said to have been revolutionized with the advent of heliotherapy. The results must be seen to be believed. Tuberculous bones and joints which have gone on to suppuration, the formation of sequestra and sinuses, not only heal comparatively quickly under the influence of ultra-violet radiation, but this agent seems to aid in the spontaneous separation and extrusion of sequestra. Kocher, in 1914, said: " It appears to me as if Nature showed us the way in which complete healing is best accomplished." Long before this date Bonnet of Lyons, in 1845, pointed out that heliotherapy was particularly useful in chronic diseases of the joints, and his successors Ollier and Poncet treated tuberculous joints by exposure to the sun's rays. Much later, in 1902, quite independently of the Lyons School and its teachings, Bernhard conceived the idea of

applying to surgery the direct bactericidal powers of the ultra-violet rays. The discovery or re-discovery arose in this way. In February 1902 Bernhard had to deal with a large, discharging wound of the abdomen, with soft spongy granulation tissue which nothing would heal. The idea came to him to try the effect of the rays of the sun. At the end of an hour and a half of direct exposure to them, a marked improvement was noticeable and the wound presented quite a different appearance. Bernhard persisted in this treatment, the granulations became visibly more normal and healthy, and the enormous wound skinned over quickly. This led him to treat all granulating and infective wounds with the sun's rays. From the excellent results he obtained with wounds, and especially sinuses, he went on to similar treatment of first open and then closed surgical tuberculosis. This was at the District Hospital at Samadan which, as Bernhard says, then became the cradle of modern heliotherapy.

Experience has proved the value of this form of treatment of sinuses. Tuberculous sinuses themselves are rapidly healed in patients undergoing ultra-violet radiation, and not only tuberculous sinuses but a bewildering variety of open sinuses seem to be favourably affected by this agent. The one factor that they have in common is sepsis, and this suggests that in the healing of the tuberculous sinus the effect of the ultra-violet ray upon the septic process is the controlling influence. The sinuses heal up and cease to discharge, the general condition of the patient becomes brighter and better, and a complete change takes place in the entire picture.

Tuberculous peritonitis is much benefited by the administration of heliotherapy, and Sir Henry Gauvan says " uncomplicated cases invariably do well." Confinement to bed, especially in severe cases, is advisable, though I have had one case who completely recovered after ultra-violet radiation who continued her occupation, that of a dancer, during the whole time of the treatment. This lasted eighteen months, but it is possible, had " simple recumbency," as Sir Henry Gauvain phrases it, been practicable, the time might have been materially shortened.

The treatment of tuberculous glands is, to-day, a combination of methods, and a condition in which team-work will give absolutely satisfactory results. The word " cure " is rarely suitable in discussing the treatment of any disease, but it is difficult to deny the word when year after year results pour in of the successful treatment of tuberculous glands. Surgery cannot be excluded in some cases, X-rays are useful in most, and sunlight in all.

It would appear that in the treatment of most tuberculous glands the use of the carbon arc light is to be preferred to that of the mercury vapour arc. Also, as a further, but essential point of treatment, a patient suffering from tuberculous glands is to be considered as an individual affected with tuberculosis, and as a consequence the treatment should be general as well as local. General treatment, or the whole body bath, should be advised as a preventive measure in those cases where a predisposition to tuberculosis may be suspected.

In confirmation of this conclusion it may be

recalled that Commander William Seaman Bainbridge presented a comprehensive and masterly communication at the Congrès International de Medicine et de Pharmacie Militaire, Rome, 1923, upon " The Influence of the World War on Surgical Tuberculosis — America's Viewpoint." [1] In this paper he summarizes the treatment, over a course of eighteen years, of tuberculous glands by surgical measures, and gives it as his considered opinion : " These observations serve to show that the effect of surgical treatment in tuberculosis of the cervical glands is inferior to the result recently accomplished by means of light therapy and X-ray treatment."

It may be as well to add also a word about those cases in which suppuration has occurred and surgery has been invoked. Ultra-violet light even then should not be neglected. Its use can not only shorten the period of recovery and render the resultant scar less disfiguring, but the probability of recurrence will be diminished.

Although it was, as has been shown, in tuberculous affections that heliotherapy won its earlier successes, and to-day in surgical tuberculosis may be said to be the method of choice, ultra-violet radiations are used to advantage in other surgical conditions. The first hundred hospital cases under my own care, 1916–17, consisted of old and unhealed wounds, trench feet, ulcers in different parts of the body, and injuries of the skin, the majority of which presented difficulties in healing. It is where this occurs that artificial sunlight is

[1] *The Military Surgeon*, August, 1924.

particularly useful. In unhealed and fetid wounds and ulcers, the good effect of ultra-violet radiation is immediately observed. The odour is overcome during the course of exposure, healthy granulation is soon established and epithelium quickly appears, the object of the radiation being to stimulate gently, and at the same time to sterilize the open surface, both processes tending to bring about soft and pliable scar tissue.

It may be interesting in this connection to refer to what Germany was doing with sunlight and war surgery. In 1915, the 14th German Army Corps started a sun clinic in the Association Hospital at Kindersolbad for those wounded in the war. The conditions for admission were :—

1. Large granulating and profusely discharging wounds.
2. Wounds due to burns, frost-bite or corrosives.
3. Wounds, the healing of which was retarded by disturbances of the circulation (varicosities) or trophic disturbances of the nerves (injuries or diseases of the spinal cord or nerves).
4. Wounds healing badly as a result of general debility or constitutional diseases, such as tuberculosis or syphilis.
5. Obstinate sinuses.
6. Delayed formation of callus in severe fractures.
7. Surgical tuberculosis.

The results in the treatment, both of indolent wounds and external tuberculosis, were excellent. The German military authorities now declared Kindersolbad a " Special Department for Radiation Treatment," and started in Dürrheim other military sun hospitals, and for this special

treatment wounded and sick soldiers came from the whole German Army.[1]

Burns of all kinds heal much more quickly if given small and frequent doses of ultra-violet radiation. The epithelium grows more rapidly and the wound assumes a healthy aspect in less time than by any other method with which I am acquainted. Also the ultra-violet radiation reduces the pain. These results are surprisingly favourable, particularly if the ultra-violet light falls on the burnt area and the surrounding skin, the former having a film of liquid paraffin over it. Paraffin, being fluorescent to ultra-violet rays, is therefore able to convert them to other wave-lengths. Growth of the epithelium is more rapid, elastic, and healthy than by any other method I have seen, and dressing can be carried out with little or no pain. The formation of keloid, which frequently occurs in scars after burns, is usually absent.

Treatment by ultra-violet radiation is suitable as a post-operative measure in wounds caused by infection. The character of the discharge improves from the beginning of treatment. Fetid wounds lose their odour, the hollows fill up with healthy granulations, pain is lessened, and the length of time of healing is considerably shortened.

In cases of empyema after operation, artificial sunlight is of the greatest service. It should be administered locally and generally. Where possible, a quartz rod should be inserted into the cavity and the effects of the radiation will be manifest after the first two or three treatments. At the London Clinic there are cases of empyema

[1] *Kriegstätigkeit des Badischen Frauenwereins*, 1914–1919, Karlsruhe, F. C. Muellersche Hofbuchdrucherei, 1919, s. 37–38.

which have lasted for years—eleven in one case—where the profuse discharge, the constant changing of bandages, and loss of weight rendered the patient's lot a misery. Very shortly after the commencement of the treatment, the discharge gradually lessened in quantity day by day, till it practically ceased, the patient's appetite returned, a state of cheerfulness replaced his continual depression and his whole attitude towards life was changed. And this after eleven years of misery! This is no isolated case and is the experience of others besides myself, both in the United States and on the Continent of Europe. Bernard says, "In sinuses also, after operation for tuberculous empyema, I have often seen complete cure by insolation, accompanied by a steady increase in weight and an excellent improvement in the general health. My experience has been equally fortunate with chronic sinuses following operation for septic or pneumonic empyema."

These rather sketchy remarks on the subject will show that sunlight has a definite place in the armamentarium of the surgeon. In some cases, as in many cases of surgical tuberculosis, it is the method of choice. It is the first weapon of attack. It is not suggested, either in surgical tuberculosis or any other condition which falls within the domain of the surgeon, that it is the only weapon, but it is certainly one which takes an important place in his armamentarium, and to-day the surgeon can no more afford to neglect the valuable aid which actinotherapy affords than he can do without the drugs and diet which the physician can prescribe, to suit the individual necessities of the case.

CHAPTER TEN

RED AND INFRA-RED RAYS

Two statements may be read, probably with surprise—(i) That the bulk of the rays used in medicine are invisible. And (ii) that though it is generally assumed that ultra-violet radiation is responsible for all the good results which have been effected by the use of one type of radiation or another, yet the quantity of ultra-violet radiation emitted from all ultra-violet lamps is small compared with other wave-lengths present. For instance, the quartz mercury vapour lamp which is almost universally believed to emit a pure ultra-violet ray, contains approximately ten times as much red- and infra-red as ultra-violet radiations. But already, the invisible and ultra-violet rays have been discussed. Remain, then, the red and infra-red rays, and these exist in far greater quantity than generally imagined and, indeed, constitute more than three-quarters of sunlight, as may be seen from a study of the spectrum of solar radiation. The health-giving properties of red and infra-red rays, however derived, have been studied far too little, and doubtless it comes as a surprise to many to learn that health-giving rays are given out by gas-fires and similar sources of energy.

The use of the red ray, that is, that ray in the visible spectrum just above the infra-red region, has been recorded from the Middle Ages to the present time: witness the well-known treatment of John Gaddesden recorded in the *Rosa Medicina*, who, when treating a patient with small-pox,

excluded all visible light except the red. This was probably in the early years of the fourteenth century, since John died in 1361.

The red rays, the lowest rays in the visible spectrum, have a wave-length of 8,000 Å and a frequency of 394 trillions per second. These rays have a power of penetration much greater than that of the ultra-violet rays, and greater even than that of some of the infra-red rays.

The body absorbs and converts into heat the infra-red rays which are of longer wave-length than the visible spectrum. Its absorption, by means of the blood and pigment, of the red rays of visible light is greater still, but not complete—a fact which can be verified by closing the eye to sunlight and observing the red glow.

There are two actions, at least, of the red ray, namely, the deep and the superficial. The superficial action is obvious, but a word may be needed to make clear its deeper action. Any form of light that is absorbed in the deeper tissue is so absorbed as a red ray, since all light passes through the capillary mesh-work; any that reaches the deeper structures must of necessity be red, and any effect produced by them must be the product of red radiation.

Another little recognized fact is that patients have been getting some infra-red rays from the sun, from gas fires, and from the various lamps in use, whether they be of the carbon or tungsten arc, or of the quartz mercury vapour type.

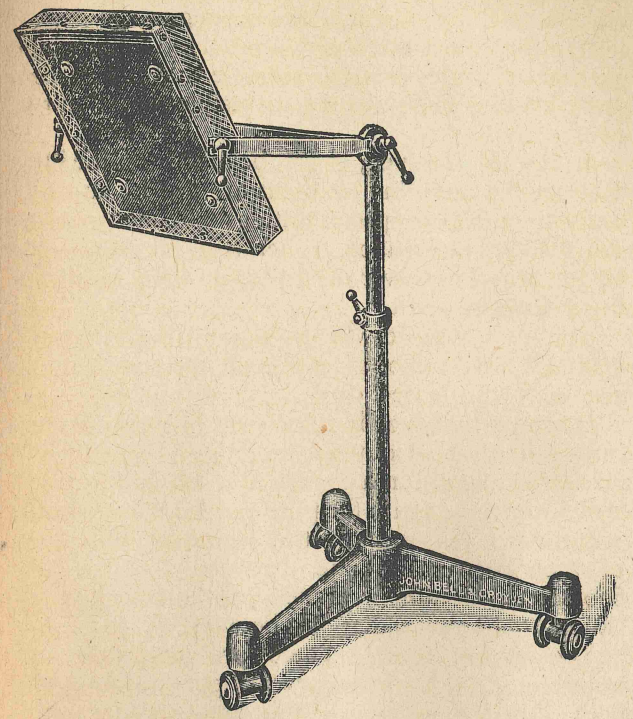
Evidence is not wanting now to prove the extreme importance of red light as a physiological and creative agent. One of the ways in which it

acts is due to the fact that it is absorbed by muscle tissue. Advantage has been taken of this in the treatment of infantile paralysis. Cases have been brought forward in which the muscles not only showed the reaction of degeneration, but the contractility was so far lost that no response could be obtained with the interrupted galvanic current. The cases had been previously treated unsuccessfully by radiation of the body and by electrical treatment of the muscles. Radiation was administered of pure red rays, derived from a carbon filament in a vacuum lamp and filtered through red stained soda glass screens, in order to cut off infra-red radiation, or most of it. When thus treated, atrophied muscles, giving no response to either faradism or galvanism before the red-light treatment, not only regained power of movement, but gave a ready response to electric stimulation. Dr. Murray Levick has no doubt but that these results were due to the absorption by the muscles of the red radiation, and that this radiation will produce in the deep tissues an increased power of resistance and repair, and an improved nutrition when this is deficient.

Until quite recently so much attention had been given to artificial sunlight and ultra-violet radiation that the subject of the value of the infra-red ray was neglected. Very little, if any, information could be found in the medical literature of this country, and we had to turn to France and other European countries and to the United States of America for guidance on the subject.

However, to-day this particular region of the spectrum is receiving a great deal of attention and

many interesting types of apparatus are being manufactured in this country. A type which is giving the greatest satisfaction, and an immense



(FIG. 12.) "ARNOLD" INFRA-RED LAMP.

volume of perfectly controlled radiation, is the Arnold infra-red lamp, two patterns of which are here depicted.

This lamp, which is suitable for use in private practice, has a single large element which radiates a considerable volume of infra-red rays. The flexibility of the outfit allows the stand to be placed over a couch, vertical, or at any angle.

The element is fitted with a small red bulb, which is used as a pilot lamp to indicate that the current is switched on. As there is no visible radiation this is necessary.

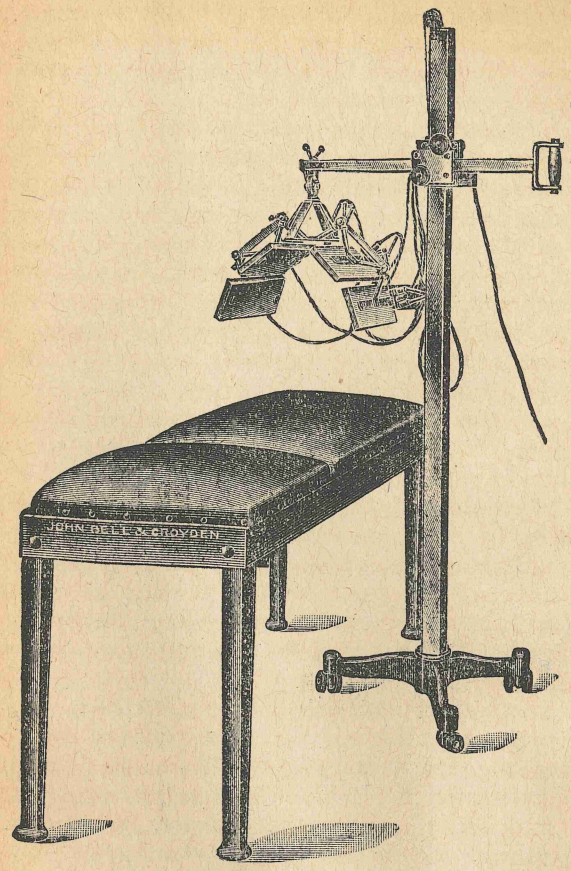
In the hospital type, as will be seen from the illustration, the radiating elements are five in number, and by means of special fittings attached may be adjusted to any shape, either straight along the body, or curved over the body, or used vertically for a sitting patient.

The stand is fitted with racking arms, both in the vertical and horizontal, so exact distance can be obtained with perfect ease.

It should be borne in mind that in working with infra-red rays, to obtain the utmost benefit, it is advisable to work in a darkened room so that there is no interference with the purity of the wave-length.

Infra-red rays occupy the whole of that part of the spectrum situate between 8,000 Å and 600,000 Å, though in practice, for medical application, only the radiations between 8,000 Å and 120,000 Å are used. These are heat rays and invisible. They have the power of penetration of the body tissues to a considerable extent and rapidly produce a hyperæmia and a redness of the skin.

Some hold that the infra-red rays have a stimulating effect on the cutaneous nerve endings, and that all the changes which follow the application of the rays are due to reflex action. It is possible, and



(FIG. 13.) "ARNOLD" INFRA-RED LAMP, HOSPITAL TYPE.

even probable, that the action is complex, and that the effects are due to physical, chemical, and reflex actions; but more laboratory investigation will yet have to be made before these matters can be decided.

Infra-red rays are primarily heat rays. As a matter of fact, heat may be said to be the absorption of infra-red rays in the human body. These infra-red rays are emitted in great quantity from metallic bodies when heated to redness or more especially to a dull red heat. Remote infra-red would consist of the radiation from a black body at 100°C. or less; these would be of comparatively long wave-length. The middle infra-red would be emitted from a hot body such as a heated flat-iron or a superheated steam-pipe; while the near infra-red would be given out from bodies heated to 500° to 700°C., i.e. at almost red heat.

Mention has just been made of the term "Black Body," a term far too important to pass over without some attempt at explanation of it. It is difficult to define, since it cannot be said to exist, and yet it is something to be reckoned with when dealing with infra-red radiation and the apparatus for producing these rays.

To try and make clear this black body, I will first premise that in the production of infra-red rays there are two principal factors: (i) the emission, (ii) the volume. In endeavouring to fix a standard by which the emission factor can be measured, Kershoff stated that if one could have a perfectly black body (which is impossible) having a perfectly non-reflecting surface (which is again impossible) then the emission factor of this black

body would be 100 per cent. The nearest approach to this ideal that has yet been found is graphite, which has an emission factor of 76 per cent. of the mythical black body.

So much for a brief explanation of the technical side of the infra-red rays. The use of these rays considerably ante-dates any scientific knowledge of them. In and from the days of Hippocrates history relates cases of pain being relieved by heat from a burning brazier, or a heated flat-iron, or from the sun's rays focussed by a burning glass.

In 1776, Dr. Faure claimed great success in the treatment of old ulceration by the use of a live coal, which he alternately approached and withdrew from the afflicted part, the patient controlling the proximity of the coal according to the heat which he felt.

A distinguished naval officer happened to mention to me that if a stoker burnt himself on a steam-pipe, he immediately opened the furnace door and exposed the affected part to the blazing fire.

Empiric as the treatments were, and though given in complete ignorance of the red and infra-red rays, have they not provided a foundation upon which modern treatment by this agent may be built up, and have they not furnished clinical evidence from which much information may be gathered when it is read in the light of modern scientific investigation?

It is probable that the relief from pain in all these cases was due to the action of the infra-red ray, or more properly speaking, infra-red rays.

Pain is, perhaps, the chief indication for the use

of this form of radiation, and the relief obtained from its use is often remarkable. The rationale of its use is easily understood in those cases of pain in which pressure can be traced as a cause. The explanation may be made clear if we take the twelve cases of neuritis following shingles, quoted by Tarchini, in which complete relief was obtained after treatment by infra-red rays. Tarchini *irradiated the painful area, that is the region of the nerve endings and also the corresponding nerve-root.* Assuming the pain of this affection to be due to minute hæmorrhagic foci and areas of inflammatory exudate situate in the nerve root, the relief of pain is doubtless caused by the resolution of the infiltrated areas under the influence of the infra-red ray; the pressure which they cause being removed, the pain is, of necessity, relieved.

The following is an incomplete and unclassified list of cases in which infra-red radiation has proved successful.

Lumbago, stiff neck, and other myalgias, neuralgias, facial neuritis, intercostal neuralgia following herpes zoster, and acute cases of neuritis, such as sciatica.

Sciatica has been relieved even when diathermy and X-rays had been tried in vain, and Armani quotes sixteen cases which had been treated unsuccessfully with hot-air baths, galvanism, salicylic ionization, X-rays, and diathermy. He obtained a complete cure in all sixteen cases with infra-red rays.

In some cases of neuritis, the infra-red lamp, applied at some distance from the patient, and continued for a period of one to two hours, is of

use. The distance should be such that the patient is conscious of a comforting sense of warmth. This treatment is not of much good in such neuritis as chronic sciatica, the treatment of which by ultra-violet radiation has already been discussed.

Another form of neuritis which benefited from infra-red rays was an intercostal neuritis—that following a dry pleurisy.

Pain in the ear—earache with no apparent cause—is often relieved by infra-red radiation; dose—one hour, three or four times a day. Perhaps one of the most striking examples of the value of the infra-red ray is its use in preventing ear troubles of various sorts. If applied at the onset of pain, pain is relieved, and further trouble does not occur. Why it should be superior to other forms of heat I cannot say, but I have learned from experience to use it in all diseases of the ear where pain is the prominent symptom, and that if the rays are applied early enough the pathological condition apparently vanishes.

In post-operative peritoneal adhesions, pain is frequently relieved by infra-red rays; the results in these cases being due to the power of infra-red rays to cause resolution or absorption of pathological infiltration.

In the dull chronic pain of an inflamed gall-bladder infra-red rays will often relieve the patient, and I have found them useful in chronic pelvic lesions. In obstinate cases of neuritis or arthritis, in reply to the question "What, if anything, relieves the pain?" should the patient reply "Warmth," I find that infra-red rays will

be the most efficacious in obtaining ultimate relief.

In the pain of traumatic injuries—after a sprain or a fracture—infra-red rays act as an immediate analgesic agent.

CHAPTER ELEVEN

PROGRESS IN THE SCIENCE OF SUNLIGHT

UNTIL the present chapter, ray therapy—or wave-length therapy, as it has been called—has been limited to the treatment of health and disease in human beings. Preventive radiation and its advantages have been lightly touched upon; but it may be as well to amplify these advantages in the matter of maternal and infant welfare. In 1925, at a conference at Arcachon, I advocated ultra-violet radiation to be administered to expectant mothers and babies in the first year, and prophesied that the irradiation of milk which was then being practised in Germany would ere long be officially adopted in this country. This prophecy has been abundantly fulfilled. In Manchester and other towns expectant and nursing mothers are deriving great benefits from ultra-violet radiation and quartz light is being used to restore failing supplies of maternal milk. At the World's Dairy Congress held in London in the autumn 1928, it was shown that milk treated with ultra-violet rays had proved its efficiency as a preventive of and a cure for rickets.

MATERNAL WELFARE AND INFANT WELFARE

Motherhood is not a disease, but it is a time of extra strain on the maternal organism, when any failure of metabolism may start a vicious circle and lead to serious consequences.

Ultra-violet irradiation at such a time is invaluable; the effect of the rays in assisting calcium intake from the food, and improving the general

health, is valuable in overcoming the vomiting, toxæmia, restlessness and debility of pregnancy. The reports on treatment given to expectant and nursing mothers in the municipal clinics of Glasgow, Manchester, Bermondsey, and other centres show that if irradiation were made available for all expectant mothers there would follow a tremendous reduction in our unnecessarily high statistics of maternal mortality.

After confinement, irradiation should be continued, at any rate intermittently, up to the time the baby is weaned. It is invaluable in assisting the mother to nurse her child. The Manchester Municipal Clinic was able to restore the supplies of maternal milk, even in cases where it had already failed, and to maintain it in others, although the mothers had resumed their occupations. An extract from the eighth annual report of the Scottish Board of Health adds valuable testimony to the value of ultra-violet radiation in Infant Welfare :—

"During a period of two months, twenty children undergoing a course of irradiation were compared with twenty children of the same age who had attended a child welfare centre. The irradiated cases each received twenty exposures. At the close of the period the average gain in weight of the irradiated cases was 2·10 lb., and of the controls 1·15 lb. In height, the irradiated cases showed an average increase of 1·6 inch and the controls 0·7 inch. It was also noted that after the cessation of treatment by irradiation increase in height and weight was even more rapid than during the course of treatment."

Irradiated Milk.—One word more on the subject of milk irradiated by ultra-violet rays. This was first given in the treatment of rickets by Alfred Hess. There were several drawbacks and difficulties to the application of the administration of it—one was that the milk acquired an unpleasant taste and smell rendering the milk distasteful to the children. This was found to be due to oxidization by the free oxygen. The Scholl method obviates this by irradiating the milk in an atmosphere of carbon dioxide. Prof. K. Scheer, Frankfurt-on-Main, has made detailed investigation on the anti-rachitic properties of milk, when so irradiated, upon rats and upon children. In the case of children it was found possible to cure rickets on an average in four to eight weeks, without any other therapeutic measures, by an administration of 300–600 c.c. of the irradiated milk. Prof. Scheer also states that he has observed striking healing results in fourteen children suffering from surgical tuberculosis who were treated with irradiated milk. The method, besides being effective, is inexpensive, the cost of irradiation being within the reach of all.

Apart from the strictly and better-known medical uses of artificial sunlight there are other aspects from which its uses may be viewed, and these will now be considered under their respective headings.

Athletic Training.—Mercury vapour light is used by several professional football clubs. It is claimed that the use of this light increases the stamina and prevents staleness in the players. Many of the competitors in the recent Olympiad, held at Amsterdam, used artificial sunlight baths while training, following in the footsteps of the old

Olympic athletes who, Philostratus tells us, were required to take the sun baths of those days.

Veterinary Uses.—It is a natural step from human to animal use of ultra-violet radiation, since many domesticated animals suffer from those diseases which respond, in human medicine, to quartz light treatment, such as rickets and surgical tuberculosis.

Horses.—Racehorses and greyhounds benefit from irradiation during training in the same way as do human athletes. There are several examples in the racing world where mares and horses have won races, and their trainers attribute their success to the fact that they had undergone a course of ultra-violet radiation. The usual installation consists of two Jesionek quartz lamps fitted at the sides of a loose box, or let into the walls. The animal is usually penned between two bars during the treatment. Such veterinary troubles as sprained and filled tendons, splints and ringbone, and leg troubles generally, girth or saddle galls, infected wounds have all received benefit from ultra-violet radiation.

The hair over and surrounding the affected part should be shaved or clipped before applying the light.

Ultra-violet radiation is also being used on stud farms for sterility in mares. Horse breeders at Newmarket have found that the irradiation of a mare in foal benefits both mare and unborn foal to an extraordinary degree, and it has also been proved that the irradiation of a foal at weaning time results in a gain of weight, whereas the usual consequence of weaning is an immediate loss.

General irradiation has an excellent effect on horses which have been hard-worked and have become stale, such as hunters after a hard season, polo ponies, etc. Some veterinary surgeons give the general irradiation for tonic treatment, whereas others irradiate only the belly. Treatment may be given thrice or even four times a week, but even more caution must be observed in the question of dosage as there is not pigmentation as a guide.

Dogs.—A recent development in veterinary surgery is the irradiation of racing greyhounds. The credit of this is due to Col. E. Middleton Perry who is the pioneer of this work. In a paper read by him before the Royal Society of Medicine he states that his experience points to the great advantages obtained by ultra-violet radiation in dogs, especially in those cases which are refractory to the usual medicaments, and even in those cases which can be cured by ordinary treatment have that time of treatment shortened when ultra-violet light is added to it. And, as Col. Perry says, a sunlight treatment " is undoubtedly a much more pleasant and cleaner way of treating some skin diseases than using the well-known dressing of sulphur and oil, etc." Would space permit evidence could be adduced from France, the U.S.A., and other countries, as to the advantages of ultra-violet therapy in the treatment of canine disorders, and, summed up, this evidence would go to prove that, apart from the tonic effects of ultra-violet rays on dogs which are already in a fair state of health, they have also a very definite beneficial result in cases of disease.

Pigs.—Strikingly good results have been obtained

on irradiating pregnant sows. The litters from them were heavier than those from the non-irradiated sows. The supply of milk was better, and the irradiated pigs could be distinguished from the non-irradiated by their sleekness and liveliness, the glossiness of their coats and the amazing way in which they throve.

It is as necessary in the treatment of pigs as in all other veterinary uses to employ the quartz mercury vapour lamp, and not the open arc lamp, which latter appears to frighten animals who will not approach near enough to the lamp to derive appreciable benefit, whereas with the quartz mercury vapour lamp pigs and other animals will go to the lamp of their own accord and lie down or stand under it. The cost is negligible compared with the increased advantages and benefits obtained.

Poultry.—Experiments conducted in poultry investigations go a long way to show, if not to prove, that there is in ultra-violet radiation an agency which can raise egg production during the winter months to summer figures, which doubles the percentage of fertile eggs and which brings on chicks so much that two-months-old birds are as strong and well-formed as three-months-old pullets. Ultra-violet radiation would appear to have the same calcium forming or fixative properties with poultry as it has with human beings, since irradiation is found to improve the quality of the texture of the shell, no small factor to those engaged in shipping eggs.

Among other advantages obtained by the use of ultra-violet radiation in connection with poultry are (1) that irradiated birds show an increased

production of eggs, and that the hatchability of these eggs is increased; (2) the mortality among young chicks is reduced; and (3) backward birds can be brought on in a remarkable manner. In fact, as a prominent firm of poultry breeders wrote to the trade journal, the use of the quartz mercury vapour lamp is the greatest step forward in the cause of the poultryman since the introduction of the incubator.

Bees.—The most recent development in the use of ultra-violet radiation is its application by the bee expert. Experiments have been recently conducted with proper controls which showed that the day after irradiation the treated bees could be distinguished from the others by their increased vitality and their energetic coming and going. They also built nearly one and a-half times more cells than the non-irradiated bees.

Industrial Uses of Ultra-violet Rays.—In industrial chemistry, ultra-violet radiation can be applied in two distinct ways. The obvious and most useful way is the full unfiltered radiation of a quartz burner, and where the rays are required to develop chemical effect this method must be used.

It is, however, also possible to use special Wood's filters, or Uviol or Chance's glass, which cut off all visible light and pass only invisible rays. These invisible rays have the property of exciting fluorescence in many substances.

Fluorescence is a most interesting and little-understood phenomenon; in brief, an object which may itself be colourless gives out, under the invisible rays, a luminescent colour, often similar to phosphorescence, except that it is extinguished

immediately the rays are turned off. Suitable substances each have their own colours, whereas imitated or adulterated forms of the substance would immediately show a difference under the rays.

It is impossible to enumerate or describe industrial uses in detail; only a few of the chief can be mentioned here.

Unfiltered rays are valuable in rapid "ageing" tests, such as are required by manufacturers of paints, varnishes, aeroplane "dope," dyes, india-rubber, textiles, and the like, for durability.

Ultra-violet lamps are standard laboratory equipment in all these branches, and their usefulness is illustrated from the results stated by one manufacturer of cellulose paints. He found that the results of a year's exposure of his product to weathering factors could be reproduced in a month under ultra-violet and heat rays in his laboratory. The utility of such a test in determining the durability of a new material is obvious.

Apart from tests, the rays are used in actual manufacture. Their effect in rapidly-hardening varnishes is an essential part in the manufacture of patent leather. In one factory at Worms alone over 15,000 quartz lamps are used for this purpose.

Foods.—A new development in industrial use is the synthesis of vitamin D. After Huldschinsky discovered that rickets was cured by exposing the human body to the rays, it was found by Hess and Steenbock that the effect could be reproduced by irradiating certain foodstuffs. This discovery led on, after much brilliant research work, to the isolation of vitamin D, the only vitamin so far isolated in this way.

Although one of the most obvious foods for this treatment, milk has only lately been successfully irradiated, as has already been noted.

Special quartz lamps are made for the intense irradiation of oils and other liquids. Water has been sterilized by this means, and future developments lie in the irradiation of oils for vitamin D.

Oil-cake and other concentrated foods on which stall cattle are fed during the winter are deficient in vitamin D, resulting in impoverished milk and ill-nourished cows. Irradiation of the food will probably obviate these troubles.

Progress in the science of sunlight is advancing even as these words are being written. New uses are being formed for ultra-violet radiation almost daily, and new proofs are being adduced as to its benefits in cases in which it is already in use. These are apparent, and one would like to quote from Holy Writ and say: "If any man have ears to hear, let him hear." And there will be some who will hear, and some who will not hear, and who elect to remain deaf to the calls to come forth from the cod-liver-oil and mustard-plaster schools of our forefathers. Let us leave them in peace.

CHAPTER TWELVE

DIFFICULTIES, DANGERS, AND CONTRA-INDICATIONS

So much has been written in books, articles, and advertisements upon the beneficent action of sunlight, whether natural or artificial, that one is apt to lose sight of the existence of any effect of radiation other than beneficial. Yet it must be admitted, and attention drawn to the fact, that the administration of ultra-violet radiation has its difficulties, dangers, and contra-indications. True, it may be that these arise from want of skill or lack of experience. This may well be, considering that up to five years ago no book of instruction exclusive to the subject had been published in this country. Since then, thousands of ultra-violet lamps have been issued to practitioners and the public, the majority of whom know little or nothing about the science of actinotherapy and still less of its dangers. Precautions may be formulated and faithfully carried out, much may be done in this way to ensure safe and satisfactory administration of what must be admitted to be this powerful agent. But these cannot take the place of a proper course of study in which scientific education is combined with clinical instruction and experience, which are three essentials of the uniformly successful administration of sunlight—natural or artificial.

It has been common knowledge from the earliest times that certain injurious effects could be caused by sunlight upon both human and animal bodies: sunburn and blistering, sunstroke and heat-stroke,

and snow-blindness have always been familiar conditions caused by sun's rays of different qualities. It is known that extensive burns of the skin may be followed by duodenal ulcers and death, and similar injuries caused by ultra-violet lamps may have equally disastrous and fatal results. One such case was the verdict of a coroner's jury last year, and though it is quite likely that this was, and will be, the only death from like causes, it is well to mention even remote possibilities.

Another case may be quoted, and although it has to do with the apparatus which supplies the ray rather than with any effect of the ray itself, yet it comes within the purview of the danger of using ultra-violet rays. A young man was found dead in a bath with an ultra-violet lamp beside him. He had purchased the lamp in order to treat himself for blackheads on the back of the neck, and had been supplied with a book of instructions which gave no adequate warning of the dangers which might attend the use of the lamp when connected to a house current. Death was attributed to shock, and an electrical expert testified that there were five different ways in which an electric shock might have been sustained from the apparatus, owing to its faulty construction and the inefficiency of its insulating material. These two cases are not quoted with any idea of frightening patients or deterring them from availing themselves of the advantages of ultra-violet radiation, but rather to point out the grave danger of harm being done and a useful therapeutic agent being brought into disrepute, if carried out otherwise than under the supervision of those qualified to

administer it. Parenthetically, it may be said, "they manage these things better in France."

But to come to the everyday difficulties. One of the first to be encountered is the difficulty of dosage. This resolves itself into a question of reaction, as does indeed every other therapeutic measure. According to the intensity of the light, the duration of exposure, and the distance from the patient, so after a latent period does the reaction appear upon normal skins.

Now, other things being equal, the reaction is directly proportional to the intensity of the radiation, and as the intensity of the radiation varies with the amperage employed, it would seem a simple mathematical matter to define and limit the reaction by the amperage employed. But there are several other factors that have to be taken into consideration. It is difficult to lay down the exact dose, because each individual skin varies in its power of resistance to actinic light. Not only does one skin vary from another, but the skin of one individual will vary—the variation depending upon the situation of the area and the amount of exposure to air and sunlight that it may have already received. An appreciation of these factors can only come with experience. Other factors than amperage, time, and distance have to be taken into consideration, and as a matter of experience one knows that some of the difficulties in estimating the dosage may be overcome by standardizing the lamp; for, as has been said, lamps vary very much in output. There are several ways of doing this, or at any rate of standardizing sufficiently, so that one is able to deter-

mine the length of exposure necessary to give the various degrees of erythema needed for therapeutic use.

In addition to the above factors which vary the dose, patients of a brunette type will require more than a blonde, sometimes a 50 per cent. larger dosage. No definite law can be laid down for dosage. Each patient, each part of a patient, and each part of a patient at different times, requires a different dose. Age and sex are yet two further factors which have to be considered when calculating the dose. Roughly speaking, it may be said that the dose for children is about half that for male adults, and for infants half that for children.

Sex, too, is another variant factor, and women's skins require a 25 per cent. smaller dose, to produce the same effect than those for adult males.

From quite another viewpoint the dosage presents difficulties, and it is this: there is a wide range, both in quantity and quality of rays generated in the apparatus of the various makers. And in the quartz mercury vapour lamp the efficiency varies inversely with the number of hours it has burned.

Enough has been said to show the difficulties of dosage, and yet the importance of its accuracy can hardly be over-estimated. If an underdose be given, the full therapeutic effect is not obtained; if an overdose be given, well, it depends upon the amount of the overdose.

There are various ways and means of calculating the correct dose, and instruments devised for the purpose. The simplest of these is that provided by the Levy-West Ultra-violet Pastilles. These

consist of small discs of card coated with a preparation sensitive to ultra-violet rays. The amount of ultra-violet radiation applied is measured by the depth of tint which the pastille will reach in any given time. An instrument has been specially designed for recording accurately the changes in colour of the pastilles. It is the Lovibond Tintometer, and consists of a tubular viewing-box divided by a central partition, so that in looking through the eye-pieces two circular apertures are seen; one side is fitted with a revolving disc holding standard tints, the other is fitted to take the exposed pastille in the holder. There are other instruments and methods of measuring, but I have found this the simplest and most effective, and the use of it will smooth away some of the difficulties of dosage. The question is much too complicated to be compressed into a chapter, or even a book. It is one which can only be understood after long experience.

The same might almost be said when dealing with the question of contra-indications of sunlight; and here, even the authorities are not agreed. Pulmonary tuberculosis, where a febrile condition exists, is generally admitted to be a contra-indication, and even in those cases where there is no fever great caution should be exercised and the patient kept under close observation.

Patients in whom there is sugar—latent or manifest—are unsuitable cases for treatment with ultra-violet radiation, and when a patient, apparently suitable for treatment, shows signs that general irradiation has not suited him, a laboratory analysis will often reveal sugar.

In practice, treatment is contra-indicated if

depression rather than exhilaration follow irradiation.

Other conditions in which it is safer to withhold than to give light treatment are all cases in which the temperature is raised above normal, especially toxæmic cases; so also in the acutely ill, or in the very old, in advanced circulatory diseases, in uncompensated cardiac disease, and bi-lateral renal tuberculosis; but it is hardly likely that patients in any of these cases would come seeking sunlight treatment.

A recent authority said: " The contra-indications to ultra-violet light baths are in conditions allied to exophthalmic goitre, quiescent phthisis, a grumbling appendix, or chronic duodenal ulcer, unless approached with the greatest care as regards minimal doses and slowness of increase."

In all of these four conditions great success has attended full body radiation. The conclusion is, therefore, that so long as the treatment is conducted " with the greatest care as regards minimal doses and slowness of increase " the contra-indications for it become less and less.

The dangers follow only with the improper administration of ultra-violet rays, and the difficulties exist but to be surmounted. The task is no simple one. There will be failures, there will be disappointments; but there will also be splendid triumphs and " exceeding great reward."

PRINTED IN GREAT BRITAIN
BY EYRE AND SPOTTISWOODE LIMITED
HIS MAJESTY'S PRINTERS
LONDON